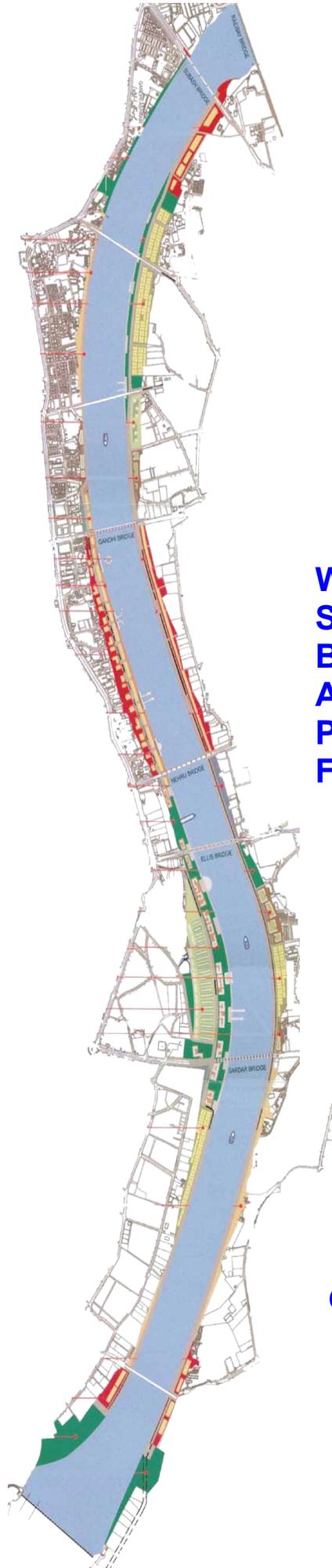


SABARMATI RIVER FRONT DEVELOPMENT



**Sabarmati River Front Development
Corporation Limited**

**2nd Floor, Riverfront House,
B/h H. K. Arts College,
Between Gandhi Bridge and Nehru Bridge,
Pujya Pramukh Swami Marg (River Front Road –
West)
Ahmedabad - 380 009**

BID DOCUMENT

**WORK OF CONSTRUCTION OF
SOUVENIR SHOP AND TICKET
BOOTH NEAR FLOWER PARK
AREA, INCLUDING CIVIL,
PLUMBING, ELECTRICAL, ELV,
FFTG & HVAC FOR SRFDCL**

Contract Package: SRFDCL

VOLUME- 02

Technical Specification



TECHNICAL SPECIFICATIONS (CIVIL WORKS)



PARTICULAR SPECIFICATIONS

1. General

Work shall be executed as per BOQ item and notes and applicable CPWD specifications. Manufacturer prescribed method of application, as approved by Engineer-in-charge, shall be adopted where BOQ item, notes & CPWD specifications or BIS standards/guidelines are not available.

If for any BOQ item of work, exact specification is not available in CPWD specifications, then CPWD specifications of nearest similar item in terms of material and/or application shall be referred as directed by Engineer-in-charge.

In case of contradictory specification between Item description and technical specifications, Decision of Engineer-in-charge regarding it shall be final and binding on the contractor.

2. Earth work

- 2.1 Contractor shall evaluate the requirement of earth for back filling within site like in basement, sides of foundations, space between retaining walls and diaphragm wall, landscaped and open spaces of site and periphery of site compound walls, excavated Trenches for service lines etc. Contractor shall submit detailed scheme for proper stocking earth at site and stacking yards and transporting it back to site, as required for backfilling of earth at site during various stages of work execution, till its completion.
- 2.2 Contractor shall give priority to stacking of earth properly and safely for reuse at site so that adequate soil is available for backfilling at site.
- 2.3 Contractor shall comply all GRIHA /Green building norms for storage of excavated Top Soil to be used for backfilling for landscaping purpose at site. Only soil suitable for reuse for landscaping shall be approved for this purpose.
- 2.4 Contractor shall take adequate measures to prevent theft, erosion, dust pollution and loss of stored earth at site and stock yard.
- 2.5 For all BOQ items, lead distance, if measurable and payable, shall be counted only from and to the entry/exit of site/stock yard/disposal site. Leads and lifts within site/stockyard/disposal yard shall not be measured and paid unless otherwise mentioned in BOQ item.
- 2.6 All items of work shall be for all lifts, depths and heights unless otherwise mentioned in BOQ item.
- 2.7 Contractor shall submit to Engineer-in-charge for approval, a detailed plan for excavation of earth, its storage at site and storage yard and disposal of surplus earth and also plans for transporting back and backfilling of stored earth. Contractor shall execute earth work according to approved plan only.
- 2.8 Contractor shall ensure safe and secure earth excavation, backfilling, transportation and stacking at all times. He will take all necessary actions to prevent sudden collapse of soil, damage to buildings, service lines, trees and other adjoining structures and harm to man and machinery at site/ yard during the execution of earth excavation, backfilling, storage, and transportation.

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- 2.9 Contractor shall be responsible for stocking/disposal, levelling and dressing of earth to required levels at site, storage yards and disposal sites.
- 2.10 For backfilling of earth, contractor shall execute the work in layers including watering and compaction to desired level of consolidation.
- 2.11 Contractor shall ensure that different types of excavated materials like earth, rock/boulders, rubbish, malba etc. are not mixed during excavation, stacking, transportation and disposal. He must segregate and dispose different types of excavated material separately.
- 2.12 Contractor shall ensure the excavated material is disposed off only to locations/sites approved by Engineer-in-charge or any non-objectionable place for all lead & lift.
- 2.13 Any charges payable for disposal of malba /rubbish to approved disposal sites shall be borne by the contractor only, unless otherwise specified in BOQ item or contractor item. However, processing charges for disposal of construction and demolition (C & D) waste generated by dismantling of existing building and structures at site, shall be reimbursed to the contractor as per the provisions for disposal of C & D waste if it is mentioned elsewhere in the contract, otherwise it shall be borne by the contractor.
- 2.14 Contractor shall execute earth work by mechanical means and manual means wherever so required.
- 2.15 Contractor shall be responsible for bailing out water (pumping out water and removing mud/slush) during *any earth work activity in under water condition or during rain or due to any other reason*.
- 2.16 Any valuable and precious item(s), structure /item of historical importance found during excavation work shall be reported to Engineer-in-charge and such item(s) shall be property of the department.
- 2.17 **Mode of measurement** – Plan area of PCC work as per drawing shall be measured for payment without considering any additional area for soil stabilization or for shuttering/formwork/scaffolding. Depth of excavation shall be measured as per drawing or as suggested by engineer in charge.

3. **Anti-termite treatment**

- 3.1 Stage of treatment may vary as per site condition and approved by Engineer-in-charge before execution.
- 3.2 The treatment against termite infection shall remain effective for a period not less than 10 years, from date of issue of the final certificate of completion of construction work. During this 10 years period, any defects in treatment are revealed or any evidence of infection in any part of the building or structure is noticed, the Contractor shall rectify the concerned defects within 15 days on receipt of notice from Engineer-in-charge. On Contractor's failure to do so the Engineer-in-charge may get the same rectified through any other agency at the Contractor's risk and cost, and the decision of Engineer-in-charge as to the cost payable by the Contractor for the same shall be final and binding to the Contractor.
- 3.3 Unless otherwise specified anti-termite treatment shall be executed through approved specialized anti termite agency. The contractor shall furnish a guarantee of 10 years on stamp paper to the Engineer-in-charge, which is also to be signed by the specialized agency. However, sole responsibility shall be of main contractor for any lapse/ termite.



- 3.4 Copy of work order issued to the specialized agency by the contractor shall be attached with guaranteed bond.
- 3.5 Guarantee bond on appropriate stamp paper shall be given by the contractor to the client in the form prescribed below:

"I/ We .(Contractor) hereby guarantee that work will remain unaffected and will not be in any way damaged by termite or any other germs of similar types, for a period of 10 years after final completion of the construction work , as per the terms and conditions of the contract and the Contractor hereby indemnifies and agrees to save the Client from any loss and/or damage that might be caused on account of termite and or other similar type of germs and hereby guarantees to make good any loss or damages suffered by the Client and further guarantees to redo the affected work without claiming any extra cost" This guarantee shall remain in force for a period of 10 years from the completion of the work under the contract and it shall remain binding to the Contractor for period of 10 years.

Provision for additional security shall be as mentioned elsewhere in the contract document.

4. CONCRETE WORK

Exposed concrete Work:

Basic specification for concrete work shall be followed as per latest specification volume of CPWD. Contactor has to prepare and submit design mix suitable to exposed concrete work. Contractor shall prepare mock-up of exposed concrete work as suggested by Architect and Engineer in charge irrespective of quantity of mockups by using different approved RMC manufacturer & approved shuttering system & material for approval by the Architect before mass execution work. Required number of exposed work mock up shall be prepared as per design intent until satisfactory finish is not received without any extra cost for shuttering work. The Architect reserves the right to reject part or all the work that is substandard or not conforming to the approved sample as per the mock up. All exposed work shall be carried out as per approved mock-up with same design mix to avoid the shade variation.

Form work for exposed concrete work

CPWD specifications clause no. 5.2.1, 5.2.2, 5.2.3, 5.2.5 shall be followed except formwork for Architectural exposed fair finish concrete surfaces (vertical or horizontal surface in any shape) in smooth finish, desired pattern and size and specifications, using good quality of shuttering material (conventional or proprietary) for all types of RCC elements as per drawing including de-shuttering, neat cleaning/ grinding the exposed concrete surface, rendering with cementitious grout of approved make (if required) with adding white cement or grey cement to match the shade, etc. The contractor



shall submit shuttering pattern including tie rod hole position based on concept drawing. The contractor shall also prepare a mock-up/ prototype for review and approval from Architect. Item shall be executed only after shuttering pattern and mock-up approved by Architect. These areas shall be even in shade, entirely free from honey combing, stains, fins, lipping, nail, or screw marks, raised grain marks, air holes or any other imperfections.

Note: Mock-up for all exposed work to be approved from Architect in all respect prior to execution. Architect reserves right to reject part or all work of substandard or not in confirmation to sample approved as per mock-up. Contractor shall demolish and re-execute rejected/ sub-standard work without any extra cost. The contractor shall get prior approval for reuse of the shuttering material for repetition.

The specifications as given in CPWD shall be followed. In addition, the Contractor shall ensure the following:

- 1) Since the exposed concrete is intended to make a visual statement, the Contractor shall ensure that the concrete on de-shuttering presents a clean and even surface. Repair/ patchwork shall not be permitted.
- 2) Form exposed corners of beams and columns to produce square, smooth, solid, unbroken lines, except as otherwise shown.
- 3) The Contractor furnished the shutter boards in largest practicable sizes to minimize number of joints and to conform to joint system shown on drawings.
- 4) All formed joints on concrete surfaces to be exposed shall be taped and shall align so that joints shall not be apparent on the concrete surfaces.
- 5) The location of all exposed features such as tie bolts, joints shall be planned in such a way that no bolt hole/ joint line etc., seems to be arbitrary and/ or out of place.
- 6) The shuttering shall be of superior quality and leak proof to avoid slurry leakage and consequent honeycombing etc.
- 7) The pattern of formwork for exposed concrete works shall be approved by the Architect prior to execution.
- 8) Approval of Architect for the shuttering material shall not absolve the contractor of his responsibility regarding the quality of finished work.

Care shall be taken to set all formwork in perfect line, level (or in required camber or slope as

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specified) and plumb. Formwork propping shall be strong, rigid and sturdy. The formwork shall be as per pattern & design shown in drawings. Formwork shall be done accurately and precisely to achieve neat, clean and smooth concrete surface, in line, level and plumb. Crimps, twists, offsets, warps, riveting etc. in plates or forms shall not be allowed. Before placing concrete, forms shall be thoroughly cleaned off of all rust, dust and loose materials. Mould release agent of approved make shall be applied on sheathing before placing the reinforcement steel. Also, the formwork material will be of black laminated plywood/ best quality steel sheathing or any sort of such material, as approved by the Architect, so that all exposed concrete surfaces have uniform colour and texture. After de-shuttering, all concrete surfaces shall be properly rendered with sandpaper or emery stone.

Exposed formwork for walls, columns, beams

For water retaining structure the shuttering plates on either side shall be bolted with tie rods made from spring coils on either side, welded with two nos. 8mm MS rods. PVC cone shall be placed on either side of the tie rod. The whole tie rod assembly along-with PVC cone shall be placed/ fixed with special type of bolts on either side of the shuttering plates. Length of the tie rod along-with PVC cone shall be equal to the width / thickness of the element to be shuttered.

For walls, columns and beams, the shuttering plates on either side shall be bolted with through tie rods made from round bars minimum 12mm with heavy quality PVC sleeves and minimum 25 mm thick PVC cones on either side of the sleeve. The whole tie rod assembly along-with PVC cone shall be placed /fixed with through bolts on either side of the shuttering plates.

Holes of tie rod in total thickness of wall shall be filled with polymer added cement mortar (1:1) or non-shrink grout in recommended proportion by manufacturer.

Intent image for exposed concrete work:



5. R.C.C. WORK:

- 5.1 Design mix concrete shall be used in the work for all structural members. For design mix concrete, relevant CPWD Specifications and IS codes shall be followed in general. Design mix for RCC shall be done considering Severe condition for RCC below ground and Moderate conditions above ground. Design mixes for different types of concrete shall be done as per grade of concrete required for different structural members and provisions of BOQ items. Type of cement and minimum cement content for design mix of concrete shall be as per BOQ item. Other ingredients and parameters for design mix concrete shall be as per CPWD specifications and IS codes.
- 5.2 The concrete shall be machine batched, machine mixed, and machine vibrated used for cement concrete shall mean the concrete produced in fully automatic concrete batching & mixing plant, placed in position by the concrete pump and vibrated by surface vibrator/ needle vibrator/ plate vibrator, as the case may be to achieve the required strength and durability.
- 5.3 The sources of coarse aggregate, fine aggregate, water, admixture & cement to be used in concrete work shall be identified by the contractor & he will satisfy himself regarding their conforming to the relevant specifications & their availability before getting the same approved from the Engineer-in-charge.
- 5.4 Generally, the entire concreting is proposed to be batched and mixed at the batching plant, of specified capacity mentioned elsewhere in these tender documents, to be commissioned at an approved place as near to site as possible by the contractor.

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- 5.5 The contractor shall submit the report on design mix from approved laboratories for approval of Engineer-in-charge within 30 days from the date of issue of letter of acceptance of the tender. No concreting shall be done until the design mix is approved.
- 5.6 In case of change of source or characteristic properties of the ingredients used in the concrete mix design during the work, the contractor as per the directions of the Engineer-in-charge shall submit a revised concrete mix design report conducted at laboratory established at site. Nothing extra shall be paid on this account.
- 5.7 All cost of mix designing and testing, connected therewith, including charges payable to the laboratory shall be borne by the Contractor including redesigning of the concrete mix whenever required & as directed by Engineer-in-charge.
- 5.8 **Establishment of Batching Plant at the approved site:** The contractor is required to establish batching plant at the site. If it is not possible to establish it captive in site, it may be established as near to site as possible. However, the contractor is required to obtain permission to establish batching plants from the concerned local bodies and from the pollution control Board as well. Moreover, as the project is planned to achieve Griha 4-star rating/equivalent rating, the contractor is required to strictly adhere to operational and quality parameters accordingly. Following parameters must be strictly adhered at batching plant by the contractor:
- (a) **Water Quality:**
- Potential pollutants in batching plant wastewater include cement, sand, aggregates, and petroleum products can increase the pH of the soil and water.
 - Many of the problems with wastewater management at batching plants have been caused by failure to recycle stored wastewater as quickly as possible. Uses for recycling tank water include concrete batching, spraying over stockpiles for dust control and washing out agitators.
 - The main sources of wastewater at concrete batching plants are:
 - Contaminated storm water runoff.
 - Dust control sprinklers.
 - The agitator washout station.
 - The agitator charging station.
 - The slumping stations.
 - Cleaning and washing.
- (b) **Air Quality:**
- Dust from cement, sand and aggregate is a pollutant. Fine dust particles can enter neighboring premises and adversely affect amenity. Dust must be controlled so there are no significant emissions from the plant.
 - Potential sources of dust pollution include:
 - Delivery of raw materials in trucks, trailers, and tankers.
 - Storage of raw materials in bunkers and stockpiles.



- Transfer of raw materials by front end loaders, conveyors, hoppers, and agitators.
 - Leakage or spillage of raw materials from silos, inspection covers and duct work.
 - The following are some of the prevention measures to be taken by the Contractor/ Builder during the operation to reduce concrete batching plant pollution so the people living around the batching plant areas are not affected by any negligence that might turn to be environmental hazard:
- (c) **Maintenance of the general site operations:**
- Maintain all the equipment including dust collection equipment to prevent any leaks.
 - Identify a buffer zone that surrounds your operations in which you are planning to contain dust generating activities.
 - Provide safety, quality and environments management system for the site and plant operations, as well as the delivery system.
- (d) **The storage silos:**
- Check for fabric (FFDC) leaks, cartridge filter system, suction, and shrouds regularly.
 - Installation of audible high-level arms on the storage silos to avoid over spilling which might damage the filters.
 - Store all the dust generating materials inside the silos e.g., cement, fly ash, ground slag, Micro silica etc.
- (e) **Fabric Filter Dust Collector (FFDC):**
- The FFDC should be sized so that the dust collector bags are not subject to clogging. Install an appropriately sized multi bag pulse jet filter in the silo, which is fitted and used in accordance with the manufacturer's recommendations.
 - The FFDC should be completely protected from the weather.
 - The FFDC needs to be made of a material which can withstand continuous exposure to cement –such as polyester and polypropylene.
 - The filter elements should be cleaned automatically at the end of the silo filling cycle.
 - The FFDC should be able to withstand the maximum pressure differential which may be encountered. A differential pressure indicator should be fitted to an alarm to indicate bag filter pressure in excess of 1.0 kPa.
 - Silos should be protected against internal pressures exceeding the design pressure. Positive type relief valves set at appropriate pressures should be installed. The relief valve should be ducted to a container on the ground, able to collect dust particles.
 - The exhaust air from the silo filters should be ducted to a dust collection container on the ground. Confirm the exhaust discharge points are visible and monitored by the driver during silo filling operations. If dust is discharged from the duct work, the driver must immediately stop filling the silo.



- Burst bag detectors should be installed in all batching plants. The burst bag detector should be connected to the automatic silo overfill protection circuit to stop the flow of cement if a filter bag bursts.
 - The FFDC should be inspected at least once a week and any necessary repairs carried out immediately.
- (f) **Raw materials:**
- Avoid using chemical concrete additives since they are more toxic. Instead, use sugar or wood-based admixtures.
 - Avoid using coal fired boiler, bottom ash, and cinder for concrete block building and instead, use aggregates.
 - Use dust suppression system to reduce suspended particulate matter in the air to a minimum.
 - Wherever possible, keep the sand and aggregates under cover so that is not blown away by wind.
- (g) **Mixer feed operations:**
- Use the enclosed batch mixer feed as dust prevention and visible emissions.
 - Use the spray device to prevent dust emissions.
 - Conduct all the mixing operations from an enclosed building to help prevent emission of dust.
- (h) **Material handling and storage:**
- Aggregates less than 5mm or less should be used in open areas. They should be stored in totally enclosed structures such as storage bins.
 - The stockpile entrance sides should be covered with a flexible curtain.
 - The opening between the storage bins and the materials weighing scale should be totally closed.
 - Sand and aggregates should be delivered in a dampened state, using covered trucks. If the materials have dried out during transit, they should be re-wetted before being dumped into the storage bunker.
- (i) **Conveyors:**
- To prevent dust emissions, the belt conveyors should be enclosed with metal board on top and on the two sides.
 - Fitting the flexible seals to prevent dust should enclose all conveyor transfer points.
 - The turning point of all the conveyors should be provided with scrappers to prevent dust collection on the surface belt.
- (j) **Mixing and loading operations:**
- Loading concrete trucks should be in such a way that minimizes dust emissions.
 - All the air borne dust emission generated by material loading and mixing operations should be vented to fabric filtering system.



- The concrete mixers and other vehicles should be cleaned off after the loading and mixing operations to wash off the mud, dust deposited on the wheels and body.
- (k) **Fugitive dust:**
- Use water sprays or dust suppression agents to reduce dust.
 - An air extraction and filtration system for collecting the generated dust should be installed.
 - The roof should be extended at least 6 feet beyond the load areas.
- (l) **Waste concrete:**
- Collect the waste concrete in suitable washout pits where it becomes gravel, sludge and sand that can later be reused.
 - The blocks and bricks leftovers can be used for ground covers, tracks, walkways, block walls or even curbs.
- (m) **Wastewater:**
- Waste and contaminated water should be directed to onsite settling ponds, and it can be reused later in for dust control, rinsing trucks exteriors.
 - In any circumstance Wastewater should not be allowed to go in contact with any fresh water bodies.
- 5.9 Under any circumstances, if RMC is to be allowed from Ready Mix plants, the contractor shall bring Ready Mix Concrete from approved RMC plants as mentioned in the preferred make list of the contract document. Following special conditions shall govern for concrete procured from RMC plants:
- (a) Notwithstanding the approval granted by Engineer-in-charge, the contractor shall be fully responsible for quality of concrete including input control, transportation, and placement etc.
- (b) The Engineer-in-charge will reserve the right to inspect at any such stage and reject the concrete if he is not satisfied with the quality of product. The contractor should therefore draw MOU / agreement with RMC owner / company very carefully in accordance to all terms and conditions / specifications of this contract document
- (c) The Engineer-in-charge reserves the right to exercise control over the ingredients, water and admixtures purchased, stored and to be used in the concrete including conducting of tests for checking quality of materials, recordings of test results and declaring the materials fit or unfit for use in production of mix. Also Engineer-in-charge shall exercise control over:
- Calibration check of the RMC plant weighing mechanism & testing equipment.
 - Weight and quantity check on the ingredients, water and admixtures added for batch mixing.
 - Time of mixing of concrete.
 - Testing of fresh concrete, recordings of results and declaring the mix fit or unfit for use. This will include continuous control on the workability during production and



taking corrective action.

- (d) For exercising such control, the Engineer-in-charge shall periodically depute his authorized representative at the RMC plant. It shall be responsibility of the contractor to ensure that all necessary equipment, manpower & facilities are made available to E-in-C and/ or his authorized representative at RMC plant.
- (e) Ingredients, admixtures & water declared unfit for use in production of mix shall not be used. A batch mix found unfit for use shall not be loaded into the truck for transportation.
- (f) All required relevant records of RMC shall be made available to the Engineer-in-charge or his authorized representative. The Engineer-in-charge shall, as required, specify guidelines & additional procedures for quality control & other parameters in respect of materials and production & transportation of concrete mix, which shall be binding on the contractor & the RMC plant.
- (g) The amount of admixture added to a mix shall be recorded in the production record. Redosing of admixtures is not normally permitted. In special circumstances, if necessary, additional dose of admixture may be added at a project site and mixed adequately in mixer itself to regain the workability of concrete with the approval of Engineer-in-charge. However, the producer/ supplier shall assure the ultimate quality of concrete supplied by him and maintain record of quantity and time of addition. amount of admixture added to a mix shall be recorded in the production record.
- (h) The various ingredients for mix design / laboratory tests shall be sent to the lab/ test houses through the Engineer-in-charge and the samples of such aggregates sent shall be preserved at site by the department. Nothing extra shall be paid on this account.

5.10 Ultrasonic Pulse Velocity Method of Test for RCC

- (a) 5% of RCC members in each category i.e., column, beam, slab and footing may be tested by UPV test method for establishing quality of concrete. The cost of testing shall be borne by the contractor.
- (b) In addition, doubtful areas such as honeycombed locations, locations where continuous seepage is observed, construction joints and visible loose pockets will also be tested.
- (c) The quality of concrete based on UPV tests shall be assessed as per IS 13311 (part 1): 1992 which stipulates following criterion:

SI. No.	Pulse velocity by Cross Probing (km/ sec)	Concrete Quality Grading
1	Above 4.5	Excellent
2	4.5 to 3.5	Good
3	3.5 to 3.0	Medium
4	Below 3.0	Doubtful



Note: In case of “Doubtful” quality, it may be necessary to conduct further tests.

- (d) Wherever concrete is found with less than “Good” quality, repairs to concrete will be made.
- (e) Honeycombed areas and loose pockets will be repaired by grouting using Portland Cement Mortar/ Polymer Modified Cement Mortar / Epoxy Mortar, etc. after chipping loose concrete in appropriate manner.
- (f) In areas where concrete is found below acceptance criteria and defects are not apparently visible on surface, injecting approved grout in appropriate proportion using epoxy grout / acrylic Polymer modified cements slurry made with shrinkage compensating cement / plain cement slurry etc. will be resorted to for repairs. Repairs to concrete will be done by the contractor at his own cost till satisfactory results are obtained as per the acceptance criteria by retesting of the repaired area and assessment of structural stability of structure by the Engineer-in-charge or his authorized representative. If satisfactory results are not obtained, action shall be taken as per CPWD specifications for acceptance/rejection of RCC/Concrete work. Decision of Engineer-in-charge shall be final and binding on the contractor.

5.11 COVER BLOCKS

- (a) Contractor shall use factory made precast CC cover blocks of approved shape and strength for all RCC works to avoid displacement of bars in any direction and to ensure proper cover. Alternatively, the contractor may manufacture the cover blocks as per approved methodology by Engineer-in-charge. The grade of concrete shall be same or higher grade as of concrete in which they will be used. The concrete in cover blocks shall be fibre reinforced concrete with 6mm downgraded aggregate. Shape & size shall be as decided by Engineer-in-charge. For horizontal surfaces CC cover blocks may be used, and vertical surfaces CC or high strength plastic circular spacers may be used, as approved by engineer-in- charge.
- (b) Below are guidelines for recommended quantities for spacers based on rebar size and application. For slabs of all dia rebars, spacing may be kept at 70 cm with two minimum number of spacers per sqm of area.

- Slabs:

Rebar Diameter	Maximum Distance	Spacers required (per sq-m)
All	70 CM	2

- Beams & Columns: Spacer Distance in the longitudinal direction:

Rebar Diameter	Columns	Beams
Up to 10 mm	50 CM	25 CM
10 to 20 mm	100 CM	50 CM



screeding running on a true surface, set at the proper elevation required to provide the specified finished elevation.

- Immediately after levelling, the concrete shall be vacuum dewatered in accordance with the recommendation of the manufacturer.
- The trowelling operation shall not be done before the concrete has hardened enough to carry the machine i.e. the trowelling blades will not leave any marks on the concrete. Repeated trowelling shall be done, with intervals between the passes, to improve the surface finish.
- Cutting of joints shall be done within 24 hours of laying of concrete as per the width & depth of joints and panel size approved by Engineer-in-charge.
- The joints shall be filled with polysulphide sealant within one month of laying of concrete after proper cleaning of joints and fixing backer rod.

7. **PLASTERING WORKS:** The item shall be executed as per BOQ item and notes, applicable CPWD specifications and manufacturer's method of application as approved by Engineer-in-charge.

7.1 Plastering shall be done using spray application except portions where spray application is not feasible, as approved by Engineer-in-charge. Ready mix polymer modified cement plaster suitable for spray application shall only be used for spray application.

7.2 Gypsum plaster shall also be done with spray gun. Gypsum suitable for spray application shall only be used.

7.3 Sand shall not be mixed in Ready mix polymer modified cement plaster and mortar, except with prior approval of Engineer-in-charge for specific requirement.

8. **WATER PROOFING WORK**

Tri-partite guarantee bond on non-judicial stamp paper shall be submitted by the main contractor and also signed by the principal manufacturer and applicator, who has carried out the waterproofing work. The guarantee bond shall be for a period of ten years from the certified date of completion of overall work. The guarantee shall be for comprehensive warranty against leakages/ seepage/ dampness and for the satisfactory performance of the entire water-proofing system.

8.1 **Concrete screed**

- (a) The item shall be executed as per BOQ item and notes and applicable CPWD specifications w.r.t concrete works. Contractor shall submit methodology statement with all detail in illustrative sketch form and get approved from Engineer-in-charge before start of work.

8.2 **Waterproofing treatment with Integral crystalline admixture/ integral crystalline slurry**

- (a) The item shall be executed as per BOQ item and applicable CPWD specifications. Contractor shall submit methodology statement with all detail in illustrative sketch form and get approved



from Engineer-in-charge before start of work.

8.3 Water proofing system with elastomeric PU (Poly urethane):

- (a) The item shall be executed as per BOQ item and notes, applicable CPWD specifications and manufacturer's method of application as approved by Engineer-in-charge. Contractor shall submit methodology statement with all detail in illustrative sketch form and get approved from Engineer-in-charge before start of work.
- (b) Following salient aspects of application shall be ensured by the contractor:
- All surfaces must be clean and free from debris, loose or flaking material, standing water, oil, grease, and organic growth. Concrete surfaces must be free from laitance and any traces of shuttering, release oils and curing compounds.
 - Before taking up the water proofing work the construction of parapet walls, including finishing should be completed. Similarly, the ancillary items like haunches, khurras, grooves to tack the fibre cloth layer, fixing up of all down take pipes, water pipes and electric conduits etc. should be completed and no such work should be allowed on the area to be treated during the progress of water proofing treatment or even later.
 - There is no necessity of hacking the surface but the surface to be treated shall be cleaned including removing the mortar dropping from the surface. Surface shall be proper grinded in very smooth manner.
 - All joints and cracks to be cut in V-groove shape (approx. 10 mmx10 mm) using mechanical cutter and clean the same to remove any loose dust, dirt etc. and same shall be filled with Polymer Modified Mortar finish in level with existing concrete surface. Allow the same to cure for 24 hrs.
 - Pipes being fixed for plumbing shall be fixed in holes which are mechanically core cut, more than the dia. of the pipes. Pipes shall be fixed by grouting the annular space with non-shrink cementitious grout of proprietary make. Before grouting the pipes shall be wrapped with a two-way self-adhesive tape atleast 2 inches wide and then grouted to fill in the grout, ensuring total watertight plumbing fittings.
 - Primer application, as required, shall carry out as per manufacturer's recommendation. PU coating shall be applied only after proper drying of primer.
 - PU coating shall be applied by spraying machine in two coats. The coats shall be applied in perpendicular directions.
 - The application of PU coating over the parapet, drainage spouts including termination



detailing shall be as per manufacturer's specifications.

- (c) The rate includes cost of all materials and labour involved in all the operations required to carry the works as per the above specifications including primer, geotextiles, surface preparation, making fillets at corners etc. complete, but excluding the cost of concrete screed.
- (d) Overlaps and tucking in a flashing groove shall not be measured. No deductions shall be made for openings or recess or chimney stack, roof lights or Khurras of area upto 0.40 sqm nor anything extra shall be paid for forming such openings, recess etc. For area exceeding 0.40 sqm. deduction will be made in the measurement for the full opening and nothing extra shall be paid for making such opening

8.4 **Waterproofing treatment with acrylic polymer modified cementitious elastomeric coating**

- (a) The item shall be executed as per BOQ item and notes, applicable CPWD specifications and manufacturer's method of application as approved by Engineer-in-charge. Contractor shall submit methodology statement with all detail in illustrative sketch form and get approved from Engineer-in-charge before start of work.
- (b) Following salient aspects of application shall be ensured by the contractor:
 - Cleaning the slab to remove loose dust, dirt, oil, debris (sunken slab for toilet or balcony) with water jetting, saturating the slab with water.
 - Repairing of cracks (if any) using polymer modified mortar, carry out cementitious injection grouting at leakage points with Plasticized Expansive Grout Admixture as per manufacturer's specification.
 - Making 50 mm thick cement mortar (1:3) vata/ fillet with Polymer modified bonding agent at dosage as per manufacturer's specifications.
 - Pipes being fixed for plumbing shall be fixed in holes which are mechanically core cut, more than the dia. of the pipes. Pipes shall be fixed by grouting the annular space with non-shrink cementitious grout of proprietary make. Before grouting, the pipes shall be wrapped with a two-way self-adhesive tape at least 2 inches wide and then grouted to fill in the grout, ensuring total watertight plumbing fittings.
 - Coating shall be applied over on to the vertical walls for a height of 1.2 m above the floor or as directed by Engineer-in-charge.
 - The last coat when wet, shall be sprinkled with quartz sand, to facilitate proper bonding the floor screed or plaster.



- (c) The rate includes cost of all materials and labour involved in all the operations required to carry the works as per the specifications including cleaning surface, repair of cracks/ joints, providing vata/ fillet, bore/ hole packing treatment etc.

9.10 China mosaic flooring

1.1 Material

All material specification shall be as per CPWD specification.

1.2 Workmanship

- 1) The sub-grade shall be cleaned, wetted and mopped. The cement slurry shall be used @ 2.75kg/sqm (with polymer based waterproofing & bonding compound) shall be applied on the sub-grade evenly. The bedding (average 25mm) shall then be laid evenly over the surface in CM 1:3 including glass fibre of approved make and as per manufacturer's specification in the desired slope as mentioned in the drawing. The bedding shall be tamped and corrected to desired level with wooden Patti. The bedding shall be allowed to harden enough to offer a rigid cushion to the tile pieces and to enable the mason to place wooden planks across and squat on it.
- 2) Broken pieces of white China mosaic shall be soaked for 24 hours before laying. The broken China pieces are laid manually as close as possible over the specified bedding (before it sets/ gets hard), which shall be laid to the required slope and gradient. While laying the broken glazed tiles, neat cement paste shall be applied over the bedding.
- 3) After China mosaic is arranged, the entire surface shall be tampered by wooden piece with a wooden mallet so that tile piece is properly embedded and levelled in the mortar and slurry starts oozing from the joints.
- 4) Vatta shall be done along with the floor keeping machine cut edges at the top end of the vatta.
- 5) At the end of day's work, the entire work shall be cleaned with the minimum quantity of water and moped with the cotton cloth. The joints shall be grouted firmly with white cement paste with the help of steel trowel.
- 6) The surface shall be cured for 7 days by ponding. After curing period is over, China mosaic shall be cleaned with water & rubbing by plastic brush to remove the dirt, excess cement etc. The surface shall then be cleaned with water and mild oxalic acid (NO ACID OTHER THAN OXALIC ACID SHALL BE USED).

1.3 Mode of measurement and Payment

The rate shall be for a unit of one sqm and shall be measured wall to wall in plan and up to the height of parapet wall from terrace. Length & breadth for plan and Length & Height for the parapet wall shall be measured correct to a cm and area shall be measured in sqm correct to two places of decimal. No extra measurement shall be given for rounding off up to 15cm.

9. METAL WORKS:

- 9.1 All metal works shall be executed as per BOQ item and notes, applicable CPWD specifications and manufacturer specification as approved by Engineer-in-charge. Contractor shall submit methodology statement, if required by Engineer-in-charge, with all detail in illustrative sketch form and get approved from Engineer-in-charge before start of work.

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9.2 Aluminium Frame Works:

- (a) All aluminium works shall be executed as per BOQ item and notes, applicable CPWD specifications and manufacturer specifications as approved by Engineer-in-charge. Contractor shall submit methodology statement, if required by Engineer-in-charge, with all detail in illustrative sketch form and get approved from Engineer-in-charge before start of work.
- (b) Contractor shall procure and install/erect the complete aluminium framework including clamps and anchors for backup support frame to stone cladding only from the specialized manufacturer for such systems, as per preferred make list.

10.3 Structural steel work -

1.0 Structural steel work & Metal work

Relevant specification of CPWD specification Vol – 1, clause no – 10.0, 10.1, 10.2, 10.3, 10.4, 10.5, 10.13, 10.17, 10.18 shall be followed except epoxy primer and PU paint of approved make and shade.

1.1 Precautions

CPWD specifications clause no. 10.4.2.3 shall be followed.

The following points shall be borne in mind during the process of welding.

- 1) Welds shall be made in flat position wherever practicable.
- 2) Arc length, voltage and amperage shall be suited to the thickness of material, type of groove and other circumstances of the work.
- 3) The segments of welding shall be such that where possible, the members which offer the greatest resistance to compression are welded first.
- 4) Proper care shall be taken while welding, for shrinkage and distortions, as the drawing dimensions are the finished dimensions of the structure.
- 5) Cutting of plates/ other member shall be profile cut with water jet or CNC machine (if required and suggested by Architect).
- 6) Welding rod shall be of approved make.
- 7) The drilling is to be done with drill or magnetic drill.

The defective welds which shall be considered harmful to the strength shall cut out and rewelded.

Finished welds and adjacent part shall be protected with clean boiled linseed oil and after all slag has been removed welds and adjacent parts shall be painted after the same are approved.

All the members shall be thoroughly cleaned of rust, cakes, dust etc. and given a priming coat of zinc chromate red oxide before fixing them in position. All fabricated members shall be suitably packed to be protected from any damage while transportation, if any.

Grinding to the finished level is to be done, if directed by Engineer-in-charge. All exposed welds shall be ground smooth. Welds which have not been ground shall be scrubbed with a 10% solution of Hydrochloric acid which shall be washed off with water before painting unless alkali resistant paint is used.



The following checking and inspection shall be carried out before, during and after erection:

- Damages during transportation
- Accuracy of alignment of structures
- Erection according to drawings and relevant specifications
- Progress and workmanship

1.2 Painting

CPWD specification clause no. 10.2.2 shall be followed except paint shall be as per Item description. First priming coat of epoxy primer is to be applied on the fresh steel arrived at site after sand blasting (if required).

Once the cutting, fabrication, grinding work gets completed, a second coat of epoxy primer and first coat of PU paint is to be applied on the priming coat.

After the paint has been already dried erection is done as specified in the item or as directed by Engineer-in-charge.

After the erection the final coat or second coat of paint is to be applied on the structural steel.

1.3 Mode of Measurement & Payment and Payment

For Riveted and bolted sections CPWD specification clause no. 10.3.5, 10.3.6, 10.4.3 shall be followed except in case of skew cut if the balance material is used at other place, same shall be deducted from quantity of skew cut i.e. Used wastage from skew cuts shall be deducted from its quantity and shall not be paid in skew cut.

The weight of steel plates, sections and strips shall be taken from relevant IS Codes, based on 7.85 kg/m² for every mm. sheet thickness, if steel is supplied by the Contractor, otherwise, the weight shall be calculated on the actual weight basis on which steel is supplied to the Contractor by the Client. If the steel is supplied by the client, testing & checking as per relevant IS code, recording and intimation of quality of steel (to client and consultant) shall be sole responsibility of the contractor.

For forged steel and steel castings, weight shall be calculated on the basis of 7850 kg/ m³.

Rolling Margin and wastage shall not be considered when weight is determined by standard weight on the basis of IS codes.

The rate includes cost of all material, labour involved in all operations as described above like erection, hoisting, scaffolding, painting as specified in item description, safety measures and sundry required for proper completion of the item of work, at all heights, all shapes, and all places. This shall also include conveyance and delivery, handling, loading, unloading, and storing etc. required for completion the item described above including necessary wastage involved.

The rate shall be for a unit of one Kg.

10. **MORTAR FOR MASONRY WORK:**

10.1 A high strength polymer modified cement based pre-mixed/ready mixed cement mortar shall be used for masonry works and cement plasters. Ready mix mortar shall be of approved make, used as per manufacturer's recommendation and as directed by Engineer-in-charge.

10.2 Technical Parameters of Mortar shall comply with IS 2250.

Density – Min 1500 Kg/ Cum

Water powder ratio – 17-19%

Compressive strength @ 28 days: Minimum 7.5 MPa.

Note for Hardware :

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Logo or brand name of manufacturer shall not be visible on surface of any hardware i.e. SS hardware, Brass hardware, Fire rated hardware etc. and same to be reviewed for sample approval.

Supplying and fixing heavy duty and high-quality fixtures and fittings for doors, windows, ventilators, partition wall, cabinets with necessary screws, nails, machine pins etc. at all floors/ all levels/ all heights complete. The fittings and fixtures hardware as described in items and as per approved make. Sample shall be approved before execution. As per description, SS hardware shall be of 304 or 316 grades from approved make list for approval, Engineer-in-charge shall decide jointly. Contractor shall use all hardware as per type of door, which are compatible with wooden/ aluminium/ metal door-windows.

All hardware shall be approved by the Engineer-in-charge. Contractor shall prepare mock-up door and window with all kinds of hardware and get it approved before mass procurement.

The manufacturer's test certificate shall be submitted for material, cycle test and other standards as required.

All hardware shall be as per approved make list.

1.1 DESCRIPTION

1.1.1 Scope

It is the intent that this section shall provide for the supply of all items of finishing hardware and adequately service this project as indicated in the Hardware Schedule and the drawings.

1.1.2 Work included

Supply of finishing hardware as scheduled including Hardware Schedule-Hardware Sets reviewing in conjunction to latest revision of Drawings and Specifications.

1.1.3 General requirements

1.1.3.1 Door hardware and furniture shall be approved types, suitable for the location and the intended function of the doors, in accordance with the Product Information and relevant Standards.

1.1.3.2 Submit Product Information, and Control Samples if directed.

1.1.3.3 Verify correct handing, internal external application, compliance to fire rating requirements, if applicable, and suitability of Hardware with the door type and door/ frame construction, floor levels, door swing limits for all Hardware items before commencing.

1.1.3.4 Include fixings, striker plates, shims, and escutcheons for a complete installation, whether indicated or not.

1.1.3.5 Unless otherwise indicated, door hardware shall enable escape from the inside of the room or area contained by the door hardware.

1.1.3.6 Door furniture shall be suitable for use with the lock or latch to which it is installed. Include key-ways, key-hole plates, turn-buttons, cut-outs, roses, plates and escutcheons required by the lock or latch type, for a complete installation, whether indicated or not.

1.1.3.7 Unless the door furniture is indicated separately for each side of the door, supply furniture as a paired set for both side of the door. Furniture fixings on the outside face of doors shall be concealed by fixing through the door from inside or by other appropriate methods.

1.1.3.8 Unless otherwise indicated, door hardware shall be manufactured from cast, forged, or machined brass with electroplated finish or stainless steel, including corrosion-resistant components, in accordance with the relevant standards.

1.1.4 Related trades

Coordinate the work of this trade with the base-structure, services, and adjacent work.

Coordinate with:

- Metal door and frames
- Wooden doors
- Tempered glass door, screen, panels
- Aluminium framed interior and exterior glazed windows, doors, and frame
- Curtain wall, Exterior entrance
- Sliding door
- Electrical services for power and control wiring for electric, electro-magnetic and electronic strikes, locks, detectors, controllers, and similar devices.
- Security service



1.1.5 Related Documentation.

Refer to:

DRAWINGS for locations and extent

MATERIAL/ PRODUCTS SCHEDULE for finish selections.

DOOR SCHEDULE

FIRE ENGINEERING REPORT for doors, if applicable.

ACOUSTIC REPORT for doors, if applicable.

1.2 REFERENCES

1.2.1 General

Comply with the current edition of all relevant standards to include:

No. of Doc. Title

EN 1670 Corrosion resistance

EN 12209 Mechanically operated locks, latches and locking plates.

EN 1303 Cylinders for locks

EN 1935 Single axis hinges

EN 1154 Controlled door closing devices

EN 1155 Elec. Powered hold open devices for swing doors

EN 1158 Door coordinator devices

EN 1906 Lever handles and knob furniture

EN 1125 Panic exit devices operated by a horizontal bar

EN 1527 Hardware for sliding doors and folding doors

EN 12365 Gaskets and weather stripping

EN 1634 Fire Testing of door and shutter assemblies.

The BHIF (Builders Hardware Industry Federation) code of practice for hardware for timber fire and escape doors.

All fire and life safety codes shall be met as required by the authority having jurisdiction.

1.3 SUBMITTALS

1.3.1 Prepare and supply 6 copies of a completely detailed hardware schedule. The schedule will list all the doors by number, size, hand, and degree of opening.

1.3.2 Indicate the handling of each door and the degree of swing. In case of pairs of doors, indicate the active door. Schedule to indicate the material, finish, dimensions, and details of fastenings for each hardware.

1.3.3 The schedule shall indicate the manufacturer's name and the article numbers.

1.3.4 Submit samples as each hardware type is specified finish and the appropriate fasteners.

1.3.5 Provide with templates and hardware schedule, original catalogue cuts of all the hardware scheduled.

1.3.6 Submit template information to the contractor for distribution to related trades.

1.3.7 Submit a key schedule for review with the Engineer-in-charge and Architect.

Approved samples may be incorporated in the works unless otherwise instructed by the Architect and Engineer-in-charge.

1.3.8 Submit affidavits to verify that hardware in each case has been installed in the correct location and that it is operating correctly.

1.4 QUALITY ASSURANCE

1.4.1 The supplier of finishing hardware shall be regularly involved in the sale and distribution of Builder's Hardware for commercial projects of this nature.

1.5 DELIVERY, STORAGE AND HANDLING

The supply shall ensure that deliver of proprietary packaged products in the manufacturer's original packages and containers with labels intact and legible, including installation instructions, templates, and detailed delivery dockets. Packaging of hardware shall be (in):

- Complete individual sets for each door.
- Separate dust and moisture proof packages.
- Clearly labelled to show intended locations.
- Complete with required fixings.



1.6 WARRANTY

All hardware shall be guaranteed for a period of one year from the date of issue of completion certificate. Material shall be covered against manufacturing defects or breakage, will-full damage excluded.

The warranty shall include particular reference to failure of, or due to, the following:

- Correct selection for required location performance
- Correct functioning of moving parts.
- Structural adequacy.
- Chipping, fading, excessive wear or delamination or other deterioration of finishes.
- Fixing and connectors including stripped threads and damaged heads.
- Integrity of seals.
- Sagging, slackness, or looseness of knobs and handles due to wear, relaxation of springs, stripped threads, or any other cause.

The warranty shall include an undertaking that spare parts and replacement items will be available for sale off-the-shelf, or with a lead time not exceeding four weeks from date of order, for a period not less than the warranty period.

Warranty shall be accompanied by a current retail price list properly identified and dated.

The warranty shall include an undertaking with respect to price control for the following items:

- Replacement keys.
- Replacement cylinders.

1.7 MAINTENANCE INSTRUCTIONS

1.7.1 Provide maintenance data, parts lists and manufacturer's instructions for installation and maintenance for each type of hardware including door closer, lock case, exit devices, etc.

1.7.2 All fixed hardware on door shutter or window shall be well protected before finishing of frame and shutter of doors and windows. Because of finishing work, coating on hardware shall not be damaged by any chemical, adhesive, sealant. Primer coat, wood polish etc. until handling over the project.

1.7.3 Provide 3 nos. copies of catalogues for all hardware used for incorporation into maintenance manual. Only original catalogue shall be used.

1.8 SELECTION

In as much as the items in the hardware schedule represent the Architect's / Engineer-in-charge's selection pertaining to weight, method of fixing, design, finish, and function, alternatives will only be considered if, in their opinion, it equals or exceeds the set standard and quality of the hardware.

All functional items (Closers, floor closers, panic device, Levers, and locks) shall be supplied by the same manufacturer to ensure operator convenience.

11. EXPOSED MASONRY WORK

11.1 General:

Bricks:

Size & strength of Bricks – as per design intent

Quality – Exposed quality architecture bricks in uniform colour (without shade variation), with sharp and linear edges (without damage), without pin holes, without bulging, without cracks etc

In case of any damage in bricks during manufacture, transportation, loading, unloading, staking, lifting, and execution shall be rejected and shall not be used in execution.

Sand for Mortar:

Sieved River/ crushed stone sand free from dust, organic material, and of a consistent and fine granulometry, to achieve the free-flowing mortar. Mortar shall be machine mixed.

Plasticizers:

If required and as suggested by manufacturer, plasticizer to be added in in mortar to achieve workability of the mortars and help in reduction of the water content of the mortar without any extra cost.

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Water:

Contractor must use only potable water, which shall be treated with softening plant (low TDS), free from contamination for all construction activity i.e., mixing, soaking, curing etc.

Reference image for exposed brick work –



Sample shall be approved before mock-up. Mock-up shall be carried out as per approved sample. Execution shall be carried out as per approved sample and mock-up.

Note: Mock-up for all exposed work to be approved from Architect in all respect prior to execution. Architect reserves right to reject part or all work of substandard or not in confirmation to sample approved as per mock-up. Contractor shall demolish and re-execute rejected/ sub-standard work without any extra cost. The contractor shall get prior approval for reuse of the shuttering material for repetition.

Any leakage and seepage shall not be allowed for brick masonry work. Contractor shall be responsible for any leakage, seepage between junction of brick work and concrete work and any other joints of brick masonry work.

11.2 Transportation to Site

Pallets of bricks shall be tied with a strong nylon rope while transporting the bricks to prevent the damage of bricks.

11.3 Storing of Bricks at site

- 1) On arrival of the brick pallets on site, check the condition of the brick pallets in the vehicle and evaluate if they are not damage.
- 2) Manual unloading shall not be allowed.
- 3) Arrange crane to unload the bricks safely from the vehicle and store.
- 4) Bricks should be stored on a hard floor (i.e. concrete/ PCC/ paved) which can remain dry and free of pests/ termites. Arrangement of hard paved floor for bricks storage shall be done and demolish after

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completion by contractor without any extra cost. Location of storage shall be as suggested by engineer in charge.

- 5) The brick pallets shall be stacked with precaution to avoid damage to bricks.
- 6) The stacked bricks should be wrapped in waterproof plastic sheets for additional protection from the elements.
- 7) Brick storage should be systematically planned to ensure minimal movement from place of storage to the masonry area.
- 8) Do not store bricks on loose soil/ ground where the topographic conditions could lead accumulation of dampness, water puddles from rainwater and wastewater from building activity.

11.4 **Shifting from Storing Area to Workplace**

- 1) Bricks should be moved from the storage area to the masoning site by mechanical means. In case of manual shifting has to done as per site constrain, contractor shall take care to avoid the damage of bricks.

11.5 **Conditions for initiating the brick laying works at site.**

- 1) Ensure all preceding concrete/ RCC structures are completed and cured beforehand to avoid contamination of brick masonry during the brick masonry work.
- 2) At the time of any construction activity (i.e. concrete work, plaster & paint work on adjoining surface, stone fixing and polishing work, any services work, etc), contractor shall protect already execute exposed brick masonry work by any means and as suggested by manufacturer and approved by Engineer in charge without any extra cost to prevent exposed brick masonry work against staining/ damage due to allied activity. In the case of failure of protecting brick masonry work, contractor shall clean/ re-execute/ making good as suggested by engineer in charge without any extra cost.
- 3) Brick masonry work shall be protected from any water/ moisture and water accumulation due to any reason to prevent efflorescence and damage of bricks.

11.6 **Process of Laying & Pointing**

- 1) Masons should inspect the bricks before laying them, the best side of the brick should be masoned to be on the front side, minor chipping, damaged edges etc should be masoned on the invisible side and as suggested by engineer in charge.
- 2) Bricks should be watered slightly to remove dust/ ash from the manufacturing process, bricks should not be over watered.
- 3) During Masonry, masons should follow the basic rules of masonry and follow the process of maintaining the required horizontal and vertical levels. After each layer the levels should be rechecked.
- 4) Curing of the mortar is essential to achieve the right strength of the masonry. Curing should be done by spraying water on the cement joints with a spraying system and then the masonry to be covered with plastic sheets in an airtight manner to minimize moisture loss.
- 5) Brick masonry area should be cleaned every night to keep the area clean of any contamination and waste mortar which could get in contact with the bricks and contaminate them.
- 6) After the bricks are laid, they should be pointed with the approved grout mix and suitable pointing tools as suggested by manufacturer.

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- 7) Utmost care should be taken during pointing by the masons so as not to stain the brick face by the grout.
- 8) Curing of the masonry wall should be done carefully to avoid large scale lime run (white stains arising out of calcium carbonate formation from the cement during the curing process).
- 9) Freshly laid walls should not be flushed with water for curing.
- 10) Do not stack bricks on the masonry area floor when it is wet.
- 11) While execution of brick masonry work, contractor shall arrange site visit of technical team of manufacturer to supervise the execution work and incorporating the observation raised during site visit in execution of brick masonry work.
- 12) Integration of door window and other MEP services work with exposed brick masonry shall be done before execution. Necessary shop drawing shall be prepared by contractor and get approved from Engineer in charge.
- 13) Brick on edge paving – Paving shall be in proper line, level and slope as per the drawing. Integration of external services work with brick paving shall be done before execution. Necessary shop drawing shall be prepared by contractor and get approved from Engineer in charge.

11.7 **Cleaning Process Post Laying**

Contractor shall execute prevention techniques that can be used both before, during and after construction, without any extra cost as follows:

- 1) Protecting brick work from rainfall during construction.
- 2) Ensuring that mortar joints are fully filled to prevent water collecting in air pockets.
- 3) Avoiding direct run-off from floor slabs.
- 4) Any cleaning activity should be undertaken at least after 30 days of brick masonry and pointing, this allows the cement in the masonry/ pointing to be sufficiently stable and not lead to further leeching of any calcium salts.
- 5) The initial staining can be removed with water and brushing before it carbonates. A bristle brush and water can be used but care must be taken not to damage the face of the bricks. Once reaction has taken place, an acid solution will be necessary because the hard crust that forms when the lime has started to carbonate is much harder to remove. The wall should be pre-dampened to minimize suction and a brick-cleaning solution carefully applied with a paint brush to dissolve the lime. If it has not disappeared after two or three attempts at light scrubbing with a bristle brush and water, then it may require more specialist treatment like cleaning of the surface of the bricks with high pressure water, this treatment leads to removal of stains.
- 6) as suggested by manufacturer and Engineer in charge.

11.8 **Protection & Maintenance Post Laying**

- 1) Cover the brick masonry with good quality plastic to avoid any contamination from other building activity like stone flooring, fabrication, electrical wiring, POP, woodwork, wood polish, drilling of any type.
- 2) After the cleaning process of the brick masonry to the desired satisfaction, apply approved water repellent.
- 3) Do not allow spraying of paint/ wood polish around bricks.

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- 4) Do not allow drilling/ nailing on the brick masonry without prior approval from Engineer in charge.

12. **DOORS – WINDOWS WORK**

Teak wood works:

All wood works items shall be executed as per BOQ item and notes, and applicable CPWD specifications. Contractor shall submit methodology statement with all detail in illustrative sketch form and get approved from Engineer-in-charge before starting work.

1. All wood used for furniture and interior works shall be kiln seasoned; termite treated superior class teak wood, selected, and sorted for uniform veins as per specifications. All visible and hidden wooden members for furniture shall be superior class teak wood.
2. Timber shall be of good quality & well-seasoned superior class teak wood. It shall have uniform colour, and shall be free from knots, cracks, and sapwood. It shall be closed grains.
The specifications of superior class teak wood are given as below:
 1. Teak logs shall be not less than 50cm in diameter and having no less than 60% heartwood.
 2. The logs shall be straight with no twisting or bending and minimal taper or fluting.
 3. The logs shall not have more than 2 knots, larger than 2 cm in diameter in any 2 meters length.
 4. The sawn timber shall have:
 - Colour – Uniform
 - Grains – Reasonably straight and closed grains
 - Dead Knots – Nil
 - Cracks or holes – Nil
 - Shakes & Sapwood – Nil
 - Moisture content – Max. 10% for less than 50mm thickness and Max. 12% for 50mm & above thickness
 5. Indian teak logs shall carry legality certification (establishing provenance/ place of origin and chain of custody) from the Indian government or relevant authorities of State or region.
 6. Remaining teak logs shall carry FSC or PEFC chain of custody (CoC) certification.

Each and every piece of the wood for doors, windows and interior work shall be duly checked & signed by the Engineer-in-charge before fabrication and finishing.

If any finished or unfinished furniture product is found to be made out from poor quality wood, Engineer-in-charge shall reserve the right to reject it. The contractor shall not claim for the same.

14. Hardware works:

All items shall be executed as per BOQ item and notes, applicable CPWD specifications and manufacturer's method of application as approved by Engineer-in-charge. Contractor shall submit methodology statement with all detail in illustrative sketch form and get approved from Engineer-in-charge before starting work.

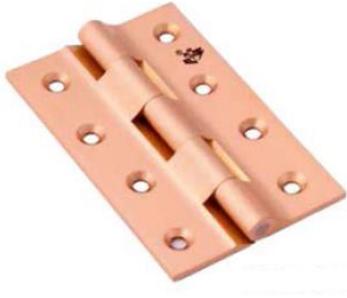
12.1 **Hardware**

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All Brass hardware shall be made of solid/ extruded brass and finished with PVD matt brass finish.

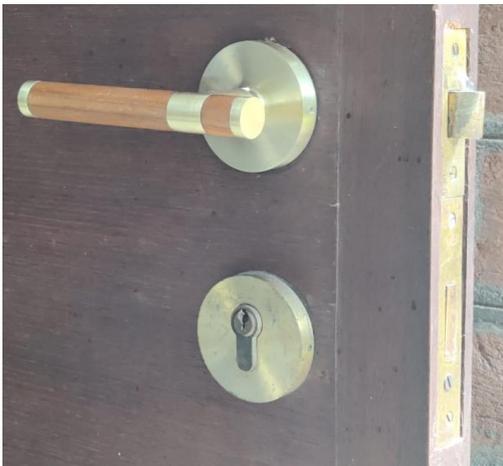
Reference image for Ball bearing Hinges



Reference image of concealed handle



Reference image of mortise latch and lock with Brass Mortise lever hand



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Reference image of Tower Bolt



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13. **WATER PROOFING WORK**

2.0 Cementitious Elastomeric Waterproof Coating

2.1 Material:

Elastomeric Polymer modified cementitious waterproofing compound shall be with following technical specifications and applied as per manufacturer's specification.

The coating shall have an elongation of a minimum of 80% when tested as per ASTM D 412, resisting 5 bars hydrostatic pressure as per DIN 1048 and having crack bridging ability of up to 2mm.

2.2 Method of Application:

- 1) Cleaning the slab to remove loose dust, dirt, oil, debris (sunken slab for toilet or balcony) with water jetting, saturating the slab with water.
- 2) Repairing of cracks (if any) with using polymer modified mortar, carry out cementitious injection grouting at leakage points modified with Plasticized Expansive Grout Admixture as per manufacturer's specification.
- 3) Carry out / making 50 mm thick cement mortar (1:3) vata/ fillet and modified with Polymer bonding agent at dosage of 2.5 Litre per 50kg cement.
- 4) Pipes being fixed for plumbing shall be fixed in holes which are mechanically core cut, more than the dia. of the pipes. Pipes shall be fixed by grouting the annular space with non-shrink cementitious grout of proprietary make. Before grouting the pipes shall be wrapped with a two-way self-adhesive tape at least 2 inches wide and then grouted to fill in the grout, ensuring total watertight plumbing fittings.
- 5) Applying first coat of Elastomeric Polymer modified cementitious waterproofing compound as primer coat as per manufacturer's specification.
- 6) Laid 80 gsm fibre mesh (alkali resistant) on first layer of coating become sandwich between two layers.
- 7) Apply second coat of Elastomeric Polymer modified cementitious waterproofing compound by brush or roller so as fibre mesh is completely covered.
- 8) Coating shall be applied over on to the vertical walls for a height of 300mm above the floor as directed by Engineer in charge.
- 9) The last coat when wet, shall be sprinkled with quartz sand, to facilitate proper bonding the floor screed or plaster.

Total water proofing system with hole/bore packing shall be applied by approved applicator of approved manufacturer's only with 10 years composite guarantee against leakages of total water proofing system to be provided by the contractor/ applicator and manufacturer.

2.3 Mode of Measurement and Payment:

The rate includes cost of all materials and labour required to carry the works as per the above specifications. The rate also includes cleaning surface and treating the cracks, joints, providing vata/ fillet and modified with bonding agent, bore/ hole packing treatment etc shall not be paid separately.

Actual applied area (plan area + wall area) of toilet/ sunken shall be measured for payment. The rate shall be for a unit of one Sqm.

3.0 Conventional (India Type) cement-based brickbat coba water proofing treatment

3.1 Material

All material specification shall be as per CPWD specification.

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3.2 Workmanship

Waterproofing treatment shall be executed through approved specialized water proofing agency. Contractor shall furnish a guarantee of 10 years on stamp paper to the employer directly and the tender rate shall be inclusive of the same which is also to be signed by the specialized agency. However, soul responsibility shall be of main contractor for any leakages.

Copy of work order mentioning the rate issued to the specialized agency shall be attached with guaranteed bond.

A guaranteed bond on appropriately stamp paper shall be given by the contractor to the client in the manner form prescribed below:

FORM OF GUARANTEE BOND

"I/We(Contractor) hereby guarantee that work will remain unaffected and will not be in any way damaged by water or any other form of humid condition, for a period of 10 years after completion of the work of water-proofing as per the terms and conditions of the contract and the Contractor hereby indemnifies and agrees to save the Client from any loss and or damage that might be caused on account of water and or other similar form of humid conditions and hereby guarantees to make good any loss or damage suffered by the Client and further guarantees to redo the affected work without claiming any extra cost."

This guarantee shall remain in force for a period of 10 years from the completion of the work under the contract and it shall remain binding to the Contractor for period of 10 years.

While tendering the contractors should clearly stipulate the type of treatment proposed to be provided by them and the name and particulars of firm through whom they propose to carry out the treatment.

Process of execution

The surface shall be cleaned of foreign matter such as fungus, moss, dirt and dust by wire brushing and dusting. Any cracks which may allow leakage of water shall be identified by ponding before starting the treatment.

The slab surface shall be washed with water and cement slurry mixed with water proofing compound as manufacture's specification as directed by engineer-in-charge shall be applied over the slab including adjoining walls upto 300 mm height including cleaning the surface before the treatment.

20 mm thick cement mortar 1:5 admixed with water proofing compound conforming to IS: 2645 and approved by Engineer-in-charge to required slope and treating similarly the adjoining walls upto 300 mm height including rounding of junctions of walls and slabs.

The surface treated shall have a minimum slope of 1 in 120 or as specified in the drawing. Brickbats of varying size (25 mm to 115mm) as per requirement shall be arranged in proper gradient with cement mortar 1:5 according to desired slope.

After three days of proper curing applying a second coat of cement slurry admixed with water proofing compound conforming to IS : 2645 and approved by Engineer-in-charge.

Finally, the surface is finished with to make wired finish with 12 mm thick joint less cement mortar of mix 1:4 (1cement :4 coarse sand) admixed with water proofing compound conforming to IS : 2645 and approved by engineer-in-charge.

The whole terrace so finished shall be flooded with water for a minimum period of two weeks for curing and for final test. All above operations to be done in order and as directed and specified by the Engineer-in-Charge.



At places of construction joints and well-defined cracks other than hair cracks in the treated structure shall be cut to 'V' section, cleaned and then filled up flush with 1:1 cement sand mortar with polymer based waterproofing compound.

The surface under treatment, part of parapet (in case of balcony or terrace) and gutters, drain mouths etc. over which the water proofing treatment is to be applied, shall be cleaned of all foreign matter such as fungus, moss and dust by wire brushing and dusting.

Drain outlet shall be suitably placed with respect to the surface gradient to ensure rapid drainage and prevention of local accumulation of water on the treated surface. Masonry drain mouth shall be widened sufficiently and rounded with cement mortar.

For cast iron drain outlets, a groove shall be cut all around to touch the treatment.

When a pipe passes through a roof on which water proofing treatment is to be laid, a cement concrete angle fillet shall be built round it, and the water proofing treatment shall be taken over the fillet.

In case of masonry parapet wall over 450 mm. in height, for tucking in the water proofing treatment, a horizontal groove 75 mm. wide and 65 mm. deep at minimum height of 300 mm. above terrace level shall be left in the vertical face at the time of construction, the horizontal face of the groove shall be shaped with cement mortar 1:4.

In case of low parapet where the height does not exceed 450 mm, no groove shall be provided, and the water proofing treatment shall be carried right over the top.

In case of existing R.C.C. and stone wall cutting the chase for tucking in the water proofing treatment is not recommended.

At the junction between the terrace slab and vertical face of the parapet wall, a fillet 75-100 mm. in radius shall be constructed.

At the drain mouths the fillet shall be suitably cut back and rounded off for each application of water proofing treatment for easy flow of water.

Outlet at every low dividing wall about less than 300 mm. in height shall be rounded smooth and corners rounded off or easy application of water proofing treatment.

The top surface shall be kept wired finish to receive the China mosaic.

3.3 Mode of Measurement and Payment

The rate shall include providing waterproof cement concrete terracing of adequate thickness to give desired slope for drainage of rainwater from terraces.

The measurements for this item shall be taken as under:

- 1) Water proofing of roof shall be measured in m²., plan area of treated surface shall be measured correct to a centimetre.
- 2) Flashing / rounding off treatment including flashing / rounding over the parapet wall up to 300 mm from terrace. Low dividing walls and expansion joints and at the pipe projections etc. Overlapping and tucking into flashing grooves shall not be measured extra and paid for.

The rate includes cost of all materials and labour required to carry the works as per the above specifications. The rate also includes cleaning and hacking the RCC parapet and inverted beam surface and treating the cracks shall not be paid separately. Cutting of horizontal grooves in parapet walls for tucking in water proofing treatment shall not be measured or paid separately.

Measurements shall be based on the drawings or as executed on site, the lesser of the two shall be



given. No extra payment shall be made for rounding and vata at the junction of slab & parapet. A deposit at the rate of 50% of the cost of this item from the running and final bills shall be recovered and retained for the first one year after completion of the work and 10% of the same or equivalent bank guarantee shall be retained for the balance of the guarantee period and shall be refunded only after the completion of the guarantee period.

The item shall be measured and paid in sqm.

The work is to be got done through approved specialized agency.

4.0 China mosaic flooring

4.1 Material

All material specification shall be as per CPWD specification.

4.2 Workmanship

- 7) The sub-grade shall be cleaned, wetted and mopped. The cement slurry shall be used @ 2.75kg/sqm (with polymer based waterproofing & bonding compound) shall be applied on the sub-grade evenly. The bedding (average 25mm) shall then be laid evenly over the surface in CM 1:3 including glass fibre of approved make and as per manufacturer's specification in the desired slope as mentioned in the drawing. The bedding shall be tamped and corrected to desired level with wooden Patti. The bedding shall be allowed to harden enough to offer a rigid cushion to the tile pieces and to enable the mason to place wooden planks across and squat on it.
- 8) Broken pieces of white China mosaic shall be soaked for 24 hours before laying. The broken China pieces are laid manually as close as possible over the specified bedding (before it sets/ gets hard), which shall be laid to the required slope and gradient. While laying the broken glazed tiles, neat cement paste shall be applied over the bedding.
- 9) After China mosaic is arranged, the entire surface shall be tampered by wooden piece with a wooden mallet so that tile piece is properly embedded and levelled in the mortar and slurry starts oozing from the joints.
- 10) Vatta shall be done along with the floor keeping machine cut edges at the top end of the vatta.
- 11) At the end of day's work, the entire work shall be cleaned with the minimum quantity of water and mopped with the cotton cloth. The joints shall be grouted firmly with white cement paste with the help of steel trowel.
- 12) The surface shall be cured for 7 days by ponding. After curing period is over, China mosaic shall be cleaned with water & rubbing by plastic brush to remove the dirt, excess cement etc. The surface shall then be cleaned with **water and mild oxalic acid (NO ACID OTHER THAN OXALIC ACID SHALL BE USED)**.

4.3 Mode of measurement and Payment

The rate shall be for a unit of one sqm and shall be measured wall to wall in plan and up to the height of parapet wall from terrace. Length & breadth for plan and Length & Height for the parapet wall shall be measured correct to a cm and area shall be measured in sqm correct to two places of decimal. No extra measurement shall be given for rounding off up to 15cm.

5.0 FLOORING WORK

5.1 Kota Stone Flooring/Kadappa stone flooring

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1) Material

All Kota stone/kadappa shall be machine cut, even shade, uniform texture/ finish and as per approved sample.

2) Workmanship

For laying and preparation of surface CPWD specifications clause no. 11.21.3 shall be followed except average thickness of CM shall be 40mm, cement mortar shall be 1:4 (1 cement: 4 sand) used.

While laying any chiselling which may be required for making the skirting or dado flush with the plaster and/or other finishes shall be done. Necessary grooves of required size in cm. between plaster and/or other finishes, dado or skirting (if required) shall be provided. Forming machine-cut/rounded edges, gutters, sills, platforms, channels, curbing, etc. if any, if required, shall be provided as per the drawing and design.

In places where full tiles cannot be fixed, the tiles shall be cut to the size and smoothed at edge to give straight and true joints.

All necessary slopes, gradients and levels shall be truly maintained as required and directed by the Architect and Engineer-in-charge.

The floor shall be kept wet for a minimum period of 7 days, so that bedding, and joints set properly.

Polishing shall be normally commenced after 14 days of laying the slab. For special polish polishing to be done with 2 coats of 60, 120 grades of emery, black chapadi and gutka. For semi mirror polish polishing to be done with 220, 320, 400, 600 grades of emery. Water shall be properly used during polishing. The flooring shall then be washed clean with oxalic acid. Daily moping for 15 days shall be done after polishing or up to the satisfaction of client and engineer-in-charge. All works shall be carried out as directed by the Architect and as specified in the item, no waxing will be permitted.

If any tile is disturbed or damaged it shall be refitted or replaced, properly jointed and polished.

The holes required for Nahni traps, pipes any other fittings shall be made without any extra cost.

3) Mode of Measurement and Payment

Kota slab/kadappa stone flooring shall be measured in m² for visible area of work done. Length and breadth shall be measured correct to a cm before laying skirting, dado or plaster. No wastage shall be considered for payment.

No deductions shall be made or extra paid for any opening in the floor area upto 0.1 m². Nothing extra shall be paid for use of cut tiles or for laying the floors at different levels in the same room or courtyard. Kota slabs laid in floor borders and bands etc. shall be measured in the same item and nothing extra shall be payable on account of these or similar bands formed of half or multiples of half size standard tiles/or other uncut tiles.

The treads of stairs and steps paved with tiles without nosing shall also be measured under this item.

The rate shall include the cost of all materials (inclusive of all taxes, levies, and delivery at site), labour & sundry involved in all the operations, at all floors, at any height and level, as described above. It shall also include for breakage and wastage. Floating materials and margin of profit shall also be included. All material samples shall be approved by the Architect/Engineer-in-charge before placing orders.

No extra shall be paid for any small quantities like narrow widths, mitred & returned ends, rounds & cutting, fixing and making good upto & around pipes, fittings and fixtures etc.

The rate shall include for fixing the flooring in composite pattern as per the drawings, using different



materials and sizes. The measurements of the different materials shall be taken category-wise separately and paid accordingly.

The rate shall be for a unit of one Sqm.

HORTICULTURE & LANDSCAPING WORK

1.0 GENERAL REQUIREMENTS

1.1 Scope

1.1.1 The scope of this section includes the preparation of planted areas and the supply, planting, protection and maintenance of trees, shrubs, vines, ground cover plants and grass of the species and size shown on the drawings. The section covers the provision of qualified labour, equipment, and material necessary to carry out all operations required for landscaping herein specified and shall be read in conjunction with all other relevant sections of the Specification.

1.2 Submittals

1.2.1 The Contractor shall submit to the Engineer-in-charge information and certificates for materials to be used for this Contract for approval.

1.2.2 Such submittals shall include, but not be limited to the following:

a. Shop Drawings:

1. The contractor shall submit shop drawings of the planting plans and details to the Architect and Engineer-in-charge for review and action.
2. The Contractor shall submit a method statement for the soft landscape installation including all milestones according to best practices.

b. Product Data:

1. Provide manufacturers certified data analysis of all standard products, including fertilizers, soil amendments, herbicides, pesticides, fungicides, showing description of ingredients, and recommendations for usage and application rates for each material to be used.

c. Samples:

1. Samples of all materials to be used in this contract shall be submitted for approval. The approved samples shall be the quality standard for the material and its placement.
2. The Architect shall inspect all plant material at the site-growing nursery.
3. The Architect shall reserve the right to reject any plant material deemed unacceptable which shall then be replaced with approved specimens

d. Certifications & Quality Control: Submit the following for approval:

1. A certified analysis by an approved laboratory for non-standard products (soil, compost).
2. Certificates confirming the origin, size, and age of all plant material.
3. Phytosanitary certificates for all imported plant material.
4. Turf: Provide certification from the grower for the type and trueness to the grass variety or strain.

e. Programs and Schedules: Provide the following for approval:

1. Schedules showing program of implementation for each type of landscape work, indicating anticipated dates and locations for each type of planting.
2. The contractor shall submit a Plant Procurement Schedule, identifying the source of every plant species, including the imported plants.
3. If necessary revised planting schedules with documentation of reasons for the revision.

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f. As-Built Drawings:

1. The As-Built drawings shall be submitted to the Architect and Engineer-in-charge for approval prior to the issue of the Completion Certificate.
2. The drawings shall include accurate documentation of the final planting installation, including but not limited to:
 - Plant material substitutions with size, genus, and species.
 - Material substitution.
 - Revisions to the scope of work.
3. On approval of the As-Built drawings, the Contractor shall forward the following:
 - Three complete sets of As-Built drawings properly folded and provided in the plastic folders as part of the Operations and Maintenance manual.
 - Annual maintenance schedule
 - One set of computer discs properly labelled and marked.

Project/ Site conditions
- 1.3.1 Weather conditions:
 - a) All work shall be carried out during the appropriate season and in weather conditions suitable for the operation.
 - b) When special conditions affect the planting times and conditions, a planting schedule shall be submitted to the Engineer-in-charge for review and approval.
- 1.3.2 Existing Services
 - a) The Contractor shall determine the location of all existing underground services prior to commencing excavation works. Damage to underground utilities shall be repaired at the Contractor's expense.
 - b) When conditions on site are considered detrimental to the plants, such as rubble, ongoing works or obstructions, the Contractor shall notify the Engineer-in-charge prior to performing the planting works.
 - c) Any excavation in confined spaces, around existing trees or in the vicinity of major utility services shall be executed by hand.
- 1.3.3 Rubbish:

All rubbish and litter as it accumulate within the landscape boundary shall be cleared and removed daily.

The areas shall be kept in a clean and tidy condition with all driveways, paths, edges, gutters and gullies swept and kept clear of debris at all times. All rubbish and debris shall be removed from site.
- 1.3.4 Oil and Petrol Storage

All oil and petrol containers are to be kept in suitable sheds provided by the Contractor, who is to observe all regulations regarding the storage of inflammable liquids. If any areas of soil are affected by oil or petrol spillage, the contaminated soil is to be dug up until uncontaminated ground is reached and removed from site and such areas made good as directed by the Engineer-in-charge.
- 1.4 Nursery
 - 1.4.1 The Contractor shall establish and maintain a suitable holding/acclimatization nursery on or adjacent to the site. It shall be protected from construction works, shaded from sun and wind, and shall be provided with an adequate supply of irrigation water. The size, location, and timing of establishing the site nursery shall be approved by the Engineer-in-charge.
- 1.5 Horticultural Supervisor

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- 1.5.1 A written approval of the Engineer-in-charge shall be obtained for the Contractor's proposed Horticultural Specialist.
- 1.5.2 The written approval of the Engineer-in-charge shall be obtained for any temporary or permanent replacements.
- 1.5.3 The Engineer-in-charge shall inspect all plants for approval and shall supervise the planting of all accents and ornamental palms.
- 1.6 Approved Chemicals
- 1.6.1 Only chemicals approved and listed by the IIHR India shall be used. All chemicals shall be non-toxic to human beings, birds, and animals and subject to the approval of a qualified specialist. The Contractor shall be liable for ensuring that all chemicals are stored separately, handled, and supplied strictly in accordance with the manufacturer's printed instructions. Neem cake shall be used as biological pesticide where specified.
- 2.0 PRODUCTS AND MATERIALS
- 2.1 Soil
- 2.1.1 Sweet soil shall be free draining, non-toxic and capable of sustaining healthy plant growth. The soil shall not contain calcium carbonate, subsoil, refuse, roots, heavy clay, noxious weeds, phytotoxic materials, coarse sand, rocks, brush, litter, or any other deleterious materials.
- The soil shall have the following characteristics:
- | | |
|--------------|---|
| 1. PH | 6.0 to 7.5 of saturated soil |
| 2. EC | less than 2500 mmhos in saturated extract |
| 3. Chlorides | <220 ppm in saturated extract |
| 4. Sulphates | <15 ppm in saturated extract |
| 5. SAR | <5% |
| 6. Nitrates | 75 ppm in saturated extract. |
- 2.1.2 Loam made up by particle size as follows:
- | | |
|--------------------------|------------|
| sand (2mm to 0.05mm) | 70% to 80% |
| silt (0.05mm to 0.002mm) | 25% to 30% |
| clay (<0.002mm) | 5% max. |
- 2.1.3 'Black' sand shall not be approved.
- 2.1.4 The representative samples of sweet soil shall be analysed for all the above characteristics and results Submitted to the Engineer-in-charge for approval.
- 2.1.5 The soil report shall include recommendations on soil amendment, and fertilizer application, depending on the soil analysis results.
- 2.2 Compost
- 2.2.1 Compost shall be approved well-rotted cow manure (poultry manure shall not be accepted), free from any deleterious matter. The rotted manure is to be guaranteed to be free from nematodes and harmful bacteria. Special care is to be taken to ensure manure is weed free (especially cypress rotundus)



- 2.2.2 Vermi compost shall be recycling of garden waste/ kitchen waste or other preferable kind of waste. It can be done by natural composting/ vermin composting and mechanical composting (In vessel Composting (OWC)) technique converts the waste into manure to increase soil fertility and used as manure. It shall be added in soil mixture as suggested by Engineer-in-charge
- 2.3 Fertilizers
- 2.3.1 General fertilizer shall be sulfur coated compound N.P.K.16-18-5+ trace elements for shrubs, trees, and grass areas, and shall be Osmocote or equal and approved by the Engineer-in-charge.
- 2.3.2 Slow-release fertilizer tablets shall be equivalent to N.P.K.18-18-5+TSE or N.P.K 17-17-4+TSE and shall be used for trees and shrubs.
- 2.3.3 Fertilizer shall be furnished in standard containers with the name, weight and guaranteed analysis of the contents clearly marked.
- 2.3.4 When a mixed fertilizer is specified, the first number shall represent the minimum percentage of soluble nitrogen, the second number shall represent the minimum percentage of available phosphoric acid and the third number shall represent the minimum percentage of water-soluble potash.
- 2.4 Planting Medium
- 2.4.1 Planting medium shall consist of a homogeneous mixture of soil, compost and fertilizers as specified.
- 2.4.2 One bag of compost shall contain 25kg of compost and shall be applied at the following rates:
- | | |
|------------------------|--|
| palm pit | One and a half bags per pit (applied 6months after planting) |
| tree pit | One bag per pit |
| shrub pit | Half bag per pit |
| grass/ground cover bed | Half bag per m ² |
| vine pit | Half bag per pit |
| shrub bed | One bag per m ² |
| bedding plants | 1 bag per m ² |
- 2.4.3 General fertilizer shall be applied at the following rates:
- | | |
|------------------------|--|
| palm pit | 175 gms per pit (applied 6months after planting) |
| tree pit | 100 gms per pit |
| shrub pit | 50 gms per pit |
| shrub beds | 100 gms per m ² |
| grass/ground cover bed | 100 gms per m ² |
| bedding plants | 100 gms per m ² |
- 2.4.4 Slow-release fertilizer tablets shall be applied at the following rates:
- | | |
|--------|--|
| trees | 21gms for every 10mm of trunk diameter |
| shrubs | 21gms for every 300mm of height |
- 2.4.5 The rates mentioned in this clause are for the first application prior to planting only. Further applications before and during the maintenance period shall be done in accordance with the Engineer-in-charge's instructions and Client's approval.
- 2.5 Planting medium for palms
Planting medium shall consist of a homogeneous mixture of soil, compost and fertilizers as specified.



2.5.1 Soil mix in all areas where palms are to be planted will consist of 30% Coco Peat, 30% Composted organic pine bark, 30% sweet sand and 10% Perlite mix.

2.5.2 Coco peat shall be coarse brown coco peat, not containing woody materials, free from sulphur and iron. Its pH value shall be in the range of 4 and 5. Organic matter content shall be 95-99% dry weight, and the water holding capacity shall be from 45-55%.

The peat shall have the following physical characteristics:

- Fibrous quality
- Brown in colour when dry
- High resistance to decay (lasting one year minimum)
- High cation exchange capacity.

2.5.3 Composted organic tree bark shall be aged over a period of 5-10 years to prevent nitrogen drawdown. The composted bark shall typically have a size range of 5-8mm and a pH value of 6.5

2.5.4 The sweet soil shall be free-draining, non-toxic and capable of sustaining healthy plant growth. The soil shall not contain calcium carbonate, subsoil, and refuse, roots, heavy clay, noxious weeds, phyto-toxic materials, coarse sand, rocks, brush, litter or any other deleterious materials.

2.5.5 The sweet soil shall have following characteristics:

- | | | |
|----|-----------|---|
| a) | PH | 6.0 and 7.5 of saturated soil |
| b) | EC | less than 2500 mmhos in saturated extract |
| c) | Chlorides | <220 ppm in saturated extract |
| d) | Sulphate | <15 ppm in saturated extract |
| e) | SAR | <5% |
| f) | Nitrates | 75 ppm in saturated extract |

Physical loam made up by particle size as follows:

Sand (2mm to 0.05mm)	70% to 80%
Silt (0.05mm to 0.002mm)	25% to 30%
Clay (<0.002mm)	5% max.

2.5.6 The representative samples of sweet soil shall be analyzed for all the above characteristics and results submitted to the Engineer for approval.

Perlite shall be used in the growing medium for its light weight, physical stability and ability to provide non capillary pore space, which improves the soil texture.

Horticulture grade perlite shall have a 25% size grading between 1.18mm and 0.0075mm.

Bulk density shall be approximately 0.1g/m³ and moisture less than 0.5%.

2.6 Plants

2.6.1 General

- a) All plants shall be of the size specified in the Plant Schedule & Planting Palette at the time of delivery to the site and shall be obtained from an approved source. The Contractor shall allow for all imported and locally sourced plants to be 'grown on' in the holding nursery in order to meet the required specification at time of planting.
- b) All plants shall be supplied as specified in tender documents and the Contractor is expected to import stock if it is not available locally. All imported plant material must be sourced from a reputable Nursery to be approved by the Architect and Engineer-in-charge prior to purchase. Plants shall be true to and supplied under Latin names. Synonyms must be checked with the Architect and Engineer-in-charge.

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- c) Engineer-in-charge shall inspect and approve all imported and locally sourced plant material at place of origin. Samples from all plant material shall be made available for approval by the Architect and Engineer-in-charge.
- d) When inspected, plants shall show no sign of pest infestation, disease, infection, nutrient deficiencies or sunscalds.
- e) All plants shall be container grown, except for field-grown palm species. Container grown nursery stock shall be vigorous, healthy, and have a well-established root system spread throughout the growing medium container to maintain a firm ball when the container is removed.
- f) All trees and particularly palms forming avenues or formal planting lines shall be selected to be uniform size and appearance all to the approval of the Architect and Engineer-in-charge. Clear stem height, overall height, and trunk girth shall be consistent and standardized among the selected trees/palms stock.
- g) The Tender must be based, without exception, upon plants that are specified. If plants are subsequently found to be unobtainable, alternatives may be submitted, stating how they differ from the Specification. Such substitutions may not be acceptable, and submission of further alternatives may be required. Approval in writing shall be obtained for any substitution.
- h) Plants shall be true to and supplied under Latin names. Synonyms must be checked with the Architect and Engineer-in-charge. Nomenclature of trees and plants shall confirm to the scientific names given in:
 - (i) Royal Horticultural Society, "Directory of Gardening"
Oxford University Press, reprinted 1974 and Supplement 1969
 - (ii) Hortus 3.
 - (iii) Exotica

All plants must agree with the botanical description in these books. Hortus 3 and Exotica are the only authorities for plants that are not listed in the RHS Directory.

2.6.2 Trees

- a) Tree stock shall be container grown, or bur lapped with geo fabric and grown in sandy beds.
- b) Trees shall have a girth of 10cm to 25cm unless otherwise specified in the planting schedule (girth/trunk circumference shall be measured at 1.0m above the soil level, excluding container height).
- c) The tree trunk shall be free of any damage caused by insect, fungal or viral infestation and free from any physical damage or scarring.
- d) The tree trunk shall be straight and vertical. There should not be any abrupt changes in girth of the trunk.
- e) The form or shape of the crown shall be typical for the specimen of the species. The crown shall not be significantly deformed by wind, pruning practices, pests or other factors.
- f) Trees shall be single stemmed unless otherwise specified.
- g) Main branches shall be well spaced with a minimum of four branches at planting.
- h) The size, colour and appearance of leaves shall be typical for the time of year and stage of growth of the tree species. Leaves shall not be damaged or discoloured.

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- i) The root system shall be free of injury from biotic (insects, pathogens) infestation and shall be uniform throughout the soil mix or growth media. Container grown nursery stock shall have a well-established root system reaching the sides of the container to maintain a firm ball when the container is removed.

2.6.3 Shrubs/ Ground Covers/Hedge/Other Plantation

- a) Shrubs and ground covers shall be twin or multi stemmed, full and bushy. The form or shape of the plants shall be typical to its species. Should be nursery grown in 12" grow bags.
- b) The size, colour and appearance of leaves shall be typical for the time of year and stage of growth of the plant species. Leaves shall not be damaged or discoloured.

2.8 Tree Stakes

- 2.8.1 All stakes shall be double stakes of timber, straight, free of projections and pointed at one end. The stakes shall be pressure impregnated with non-injurious wood preservative to be applied at least two weeks before use.
- 2.8.2 Stakes shall be stained green. A sample shall be submitted and approved by the Architect and Engineer-in-charge.
- 2.8.3 The tripod type tree guard/ tree stakes be made out of 3 no 50mm dia and approximate 2.5 mt long (2.0 mt above ground and 0.50 mt below ground) Eucalyptus/ Cedar stakes.
- 2.8.4 The tree guard stack shall be painted with bituminous paint at below ground portion plus 150mm above ground portion. The tree guard shall be installed vertically outside the root ball properly, so tree grown in upright position. The tree guard shall be maintained up to the tree become well set and as directed by architect and Engineer-in-charge.
- 2.8.5 For Climber, contractor shall provide vertical support (i.e., metal wire/ frame, jute thread, or similar kind of support suitable to type of species) as per site condition during plantation and as approved by Engineer-in-charge.

2.9 Tree Ties

- 2.9.1 Tree stakes shall be tied to stem of planted tree with rubber tie/ patta of size 30mm x 10mm in twisted pattern as per drawing. Trees shall be supported by two stakes each and shall be fixed to the tree by a suitable rubber tie.



2.10 Temporary Planting Screens

2.10.1 Whenever planting in an exposed position liable to extreme prevailing wind conditions and windbreaks shall be provided until such time as the planting is firmly established. Screens shall

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be 1750mm high shade cloth of 75% density supported on a firm wooden frame of adequate size and diameter so as not to disturb the growth of the plant.

2.11 Anti-desiccant

2.11.1 Anti-desiccant shall be an emulsion type, film-forming agent designed to permit transpiration but retard excessive loss of water from plants. This is to be done during transplanting.

2.12 Mulch

2.12.1 Mulch shall be tree bark mulch or smooth river pebbles of the following random distribution size:

Length: 10mm - 60mm
Width: 10mm - 50mm
Thickness: 4mm - 10mm

2.12.2 Certified product data and sample shall be submitted and approved by the Architect and Engineer-in-charge.

2.12.3 Mulch shall cover all shrub beds, in a 75mm layer, unless otherwise specified by the Architect and Engineer-in-charge.

2.13 Pruning Paint

2.13.1 Pruning paint shall be waterproof, antiseptic, adhesive, elastic and free of kerosene, coal, tar, creosote and other substances harmful to plants.

2.14 Drainage layer system

2.14.1 The Contractor shall install a gravel drainage layer, as per the Detail Drawings, to all in situ planters with slab bases. The gravel drainage shall be 150mm washed river pebbles with a layer of geo textile placed on top and wrapped up the sides of the planters.

2.15 Soil Separator Membrane/Geo textile Fabric

2.15.1 Non-woven, synthetic, continuous fiber isotropic felt 70% polypropylene 30% polyethylene, weight 125gms/sq.m, thickness 1.0mm, with good permeability to water, resistant to all naturally occurring soil acidities and resistant to tearing and stress. To be laid with 300mm overlaps at junctions.

3.0 EARTHWORKS

3.1 Setting out

3.1.1 The Contractor's calculations for setting out from established points shall be available for inspection by the Engineer-in-charge.

3.1.2 The Contractor shall take all necessary precautions during the progress of the works to ensure that coordinated points are not damaged.

3.2 Site Levels

3.2.1 The Contractor shall check that the existing ground levels as indicated on the drawings are correct. Should there appear to be any discrepancies the Contractor shall agree the correct level with the Engineer-in-charge.

3.2.2 Prior to the commencement of any excavation or earthworks the Contractor shall furnish the Engineer-in-charge for his approval, drawings and / or schedules indicating the existing site levels on a suitable grid.

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3.3 Records

3.3.1 If the Engineer-in-charge requires foundation depths to be varied from those shown on the drawings it shall be the responsibility of the Contractor to ensure that proper records of the actual excavated levels are kept.

3.3.2 The Contractor shall ensure that the revised levels area measured in the presence of the Engineer and are clearly identified, recorded, dated and signed as agreed by both parties.

3.3.3 Where excavation meets the water table, detailed records of ground water levels, including any tidal variations shall be maintained.

3.4 Site Investigation

3.4.1 Site Conditions

i). The Contractor shall be deemed to have satisfied himself as to the character of the site and all the various materials, strata, ground water levels etc., and of all items and things liable to affect or be encountered in the excavation and earthworks.

ii). Any site investigation reports included in the Contract Documents are provided solely for the guidance of the Contractor and no guarantee is given regarding their accuracy, nor it is guaranteed that similar condition apply elsewhere on site.

iii). The Contractor is entirely responsible for informing himself to the conditions of the site and for carrying out such additional investigations at his own cost as he may consider necessary prior to submitting his tender or during the course of construction of the works.

3.5 Special Requirements of Statutory Authorities

Prior to commencing excavation work the Contractor shall ascertain from the responsible departments whether any mains or services are to be diverted or cut off.

4.0 MATERIALS

4.1 Definitions

4.1.0 Suitable Material

Suitable material shall comprise all material that is acceptable in accordance with the contract for use in the works. Suitable material for earthworks shall be approved non-plastic soil obtained from excavations within the works, or from borrow pits approved by the Engineer-in-charge. It shall not contain an excess of fines or organic material where the material is to be placed below road or building construction it shall comply with 4.1.2 below

4.1.1 Unsuitable Material

Unsuitable material shall comprise

- a) Organic material, stumps and other perishable material
- b) Material susceptible to spontaneous combustion
- c) Cohesive materials of liquid limit exceeding 25% and plasticity index exceeding 6.
- d) Material with an excessive moisture content
- e) Any other material which the Engineer may deem unsuitable for earthworks
- f) Dredged material unless approved in writing by the Engineer
- g) Stones larger than 10 mm dia.

4.1.2 Embankment Fill

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- i Embankment fill shall imported form an area approved by the Engineer-in-charge.
- ii It shall be the responsibility of the Contractor to locate suitable material and carry out such tests as the Engineer-in-charge may require to demonstrate the suitability of the fill to be supplied.
- iii The fill shall have a maximum stone size of 75 mm liquid limit not exceeding 25% and plasticity index not exceeding 6. Total water-soluble salts shall not exceed 3%.
- iv Material shall have a CBR not less than 30% at 95% maximum dry density.

4.1.3 Rock

Rock shall mean those geological strata or deposits so designated on the drawings and any hard, natural or artificial material requiring the use of approved pneumatic tools or blasting or its removal but excluding individual masses of less than 0.20 cubic meters.

5.0 PLANT FOR EARTHWORKS

5.1 General

All plant and equipment used for earthworks shall be maintained in good working condition for the duration of the works. The Contractor shall supply adequate quantities and types of plant and equipment for the proper execution of the works in an expeditious manner.

5.2 Plant and Equipment

5.2.1 General

The main items of plant and equipment shall comply with the requirements detailed bellow. All plant shall be operated only by trained operators and banksmen shall be provided where necessary

5.2.2 Bulldozers

Bulldozers shall be tracked /pneumatic tyred vehicles equipped with a blade for earth moving / levelling and ripper teeth where necessary. The blade level shall be hydraulically controlled.

5.2.3 Tractor Shovel

Tractor shovel shall be tracked or pneumatic tyred vehicles equipped with a shovel for earthmoving. The shovel shall be hydraulically controlled.

5.2.4 Rotary Cultivators

Rotary Cultivators shall be purpose designed to ensure proper pulverization and mixing of soil. Cultivators shall be equipped with metal teeth or plates.

5.2.5 Motor Graders

Motor graders shall be pneumatic tyred vehicles, equipped with hydraulically controlled blades, capable of both level and angular adjustment.

5.2.6 Water Sprinklers

Water sprinklers shall be mounted on pneumatic tyred trucks equipped with suitable pumping and water distribution equipment. The distributors shall be designed to add water to the soil uniformly and in controlled quantities.

5.2.7 Pneumatic Tyred Rollers

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Pneumatic tyred rollers shall be equipped with tyres of equal size and diameter, uniformly inflated. The wheels shall be spaced such that one pass will achieve complete coverage equal to the rolling width of the machine. Pneumatic tyred rollers may be towed or self-propelled.

5.2.8 Steel Wheeled Rollers

Steel Wheeled rollers shall be one of the following types:

- i Three wheeled rollers – shall be self-propelled and equipped with a reversing clutch, differential drive and have adjustable scrapers to keep the wheel surface clean. The wheels shall be spaced such that one pass will achieve complete coverage equal to the width of the machine.
- ii Tandem rollers – shall be self-propelled and equipped with reversing clutches, a sprinkling system to spray front and rear rolls and adjustable spring scrapes fitted to each roll.
- iii Vibratory tender rollers – shall have a static weight of at least 5000 kg and a vibratory frequency between 1500 and 2000 cycles per minute.
- iv Single drum vibratory rollers – shall be double axel, self-propelled rollers with rear axle equipped with pneumatic flotation tyres. The steel roll shall have a vibrating frequency between 1500 and 2000 cycles per minute

6.0 EXCAVATION

6.1 General

6.1.1 Line and Levels

Excavation shall be carried out to such lengths, widths, depths and profiles as are specified or shown on the drawings plus any necessary allowance for working space for temporary works.

6.1.2 Oversized Excavations

Where excavations are taken out to greater depths, widths or lengths than required, the Contractor shall make good with concrete or other approved compacted material.

6.1.3 Support of Excavations

The sides of excavations shall be adequately supported to prevent slips or subsidence and shall be close sheeted where necessary to prevent the entry of running sand, mud etc.

6.1.4 Formation Levels

Where the excavated level forms the formation level for subsequent construction, the surface shall be suitably compacted to the satisfaction of the engineer prior to the commencement of any subsequent construction works. Compaction shall be to 95% maximum dry density.

6.2 Removal of Water

6.2.1 Removal of water

The excavation shall at all times be kept free from standing water from whatever source arising by pumping or other means.

6.2.2 Adjacent Structures

The Engineer shall be informed should continuous or near continuous pumping be required. If necessary, arrangements shall be made for the prevention of withdrawal of support from adjacent structures.

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6.3 Soft Spots

6.3.1 General

- i The bottom of all excavations shall be proved, and any poor bearing area shall be reported to the Engineer, who will direct remedial work.
- ii Soft spots shall be cut out and filled with either approved compacted fill or concrete as directed by the Engineer.

6.4 Inspections:

6.4.1 Engineer-in-charge's Approval

No excavation for foundations shall be filled in or covered with concrete until the Contractor has notified the Engineer that is ready for inspection and has received his sanction to proceed with the works. The Contractor shall give a minimum of 24 hours' notice of any inspection.

7.0 FILLING

7.1 General

7.1.1 Engineers Approval

Excavations shall only be backfilled after the permanent works therein are approved by the Engineer and after the removal of any building debris or deleterious material from the excavations. All final level formations shall be within a tolerance of (+) or (-) 25 mm.

7.1.2 Selected Material

Selected excavated material shall normally be used for backfilling. Selected material shall comply with the requirements of 4.1.0 and 4.1.2 above. Where the excavated material is not considered suitable by the Engineer, selected material from an approved source shall be used.

7.1.3 Backfill Grades

The backfill shall be brought to a suitable level above grade to provide for anticipated settlement and unless indicated otherwise, shall be sloped away from structures.

7.2 Compaction

7.2.1 Compaction Plant

Compaction shall be approved compaction plant as scheduled in Section 5.0 or plate type vibrators, pedestrian operated vibrator rollers, small tandem rollers or other approved plant.

7.2.2 Placing and Compaction

Unless otherwise stated below, the procedure shall be as follows

- i The material shall be placed in loose layers within the effective range of compaction plant; however, the maximum compacted layer thickness shall be limited to 150 mm irrespective of plant type.
- ii The material shall be watered and mixed as necessary to ensure that prior to compaction the moisture content of the whole layer is within +2% of the optimum moisture content. Compaction

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of each layer shall continue until a density of at least 95% of the maximum dry density has been achieved, unless otherwise specified on the drawings.

7.2.3 Fill below Ground Slabs

- i The installation of cable ducts for service entries and service pipe work shall be completed before preparation of the fill to receive ground slabs.
- ii The compacted material shall be shaped and trimmed to the required levels and dimensions and blinded with sand other approved find material which shall also be watered and compacted to provide a smooth surface.

7.2.4 Sweet soil to Planted Areas

- i Where fill material is placed to areas designated for planting, the material shall be sweet soil as described above.
- ii Sweet soil shall be compacted by the application of water only. No compaction plant shall be used.
- iii The material shall be placed in layers not exceeding 200 mm well-watered and mixed to ensure full saturation.
- iv Material shall be placed to achieve the contours shown on the drawings. On completion of filling final profiling shall be carried out to avoid flat grades and abrupt changes of level or direction and to create a smooth, curved cross sectional profile.

7.3 Workmanship

7.3.0 Soil Grading and Preparation

7.3.1 Subsoil shall be excavated to achieve tolerances of (+) or (-) 25 mm specified for finished level of soil, and when reasonably dry and workable, graded to smooth, flowing contours with all minor hollows and ridges removed.

7.3.2 Non-cohesive, light subsoil shall be loosened with a three-time ripper, 300 mm deep at one-meter centers. Stiff clay and other cohesive subsoil shall be loosened with a single tine ripper to a depth of 450mm at one-meter centers.

All perennial weeds and undesirable plant and scrub growth shall be manually removed or treated with herbicides, and the period of time recommended by the manufacturer shall be allowed to elapse before grading. The contractor shall obtain approval from engineers before any plants are removed.

7.3.3 All weeds, rocks and other debris shall be removed and disposed of. Finished ground level adjoining buildings shall be kept 150 mm below the level of the damp-proof course.

7.4 Handling and Transportation of Plants

7.4.1 Plant material shall be lifted or moved in such a manner that the roots are not disturbed. Plant material shall be lifted or moved by holding the container and not the stem or foliage.

7.4.2 Root systems of all plants shall not be allowed to dry out at any time and shall not be exposed to excessive or artificial heat or to freezing temperatures.

7.4.3 During transportation all plants shall be packed correctly to ensure protection from climatic or physical injuries. Tarpaulins or other covers shall be placed over plants when they are transported by trucks or in open freight cars.

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- 7.4.4 Immediately prior to lifting, palm trees shall have their fronds reduced in length by 30%, sprayed with anti-desiccant and tied up with 3 layers of hessian to enclose the growing tip. The roots shall be pruned, and the root ball protected with three layers of hessian secured with wire and kept constantly moist with wet straw or other suitable material.
- 7.5 On-site Acclimatization and Storage
- 7.5.1 Plants shall be kept at the site nursery, in shaded areas until planted. Plant material shall be protected from wind exposure, and direct sunlight, and shall be watered correctly.
- 7.5.2 All imported plant materials shall be delivered to site nursery for acclimatization within the first six months of the contract period, unless approved otherwise by the Architect and Engineer-in-charge and protected against drying at all times.
- 7.5.3 Palm trees shall be planted directly on arrival on site. If palms have to be held for longer than twenty-four hours before planting they should be 'heeled-in' in trenches which are kept moist at all times.
- 7.5.4 Soil, compost, fertilizers and other products shall be delivered to the site nursery, and stored in appropriate locations to avoid contamination, and wetting until the soil mixing operations.
- 7.6 Planting Timing
- 7.6.1 Planting shall take place before 1000 hours and after 1630 hours but can be carried out at other times if the Architect and Engineer-in-charge gives approval.
- 7.6.2 Prior to planting all grading and ripping, paving, laying of services and other builder's work shall be completed. The irrigation system shall, wherever possible, shall be operational and soil brought to field capacity.
- 7.7 Medium Preparation
- 7.7.1 Specified soil additives shall be mixed with sweet soil at the rates specified.
- 7.7.2 Application rates for ameliorants and soil mix components shall be checked and approved by the Architect and Engineer-in-charge and Client prior to mixing each batch.
- 7.7.3 The soil shall be mixed mechanically by an approved method to create a homogeneous mixture. Mixing of planting medium shall be accomplished at one centrally located section on a raised concrete slab to prevent contamination of field soil from diseases, weed seeds, and nematodes transported by run-off water.
- 7.8 Planting
- 7.8.1 The sequence of planting shall be as follows:
- a) Grade soil as specified.
 - b) Stake out the outline of planting areas and individual tree and shrub locations for approval by the Architect and Engineer-in-charge.
 - c) Excavate planting areas and individual pits to the sizes specified for palms, trees, shrubs, groundcovers, flowers and grass. Excavated sub-soil shall be removed from site and shall not be mixed with the planting medium or used to form berms around the plants.
 - d) Fill planting pit with irrigation water and ensure the water can drain away. In case of poor drainage, a percolation test shall be carried out and drainage holes augured if required.



- e) Backfill pit/beds, after having been tested for drainage with approved planting medium in layers not exceeding 300mm and water compact. Allow for compaction/subsidence by overfilling by 100mm. Once placed the growing medium shall be covered with plastic sheeting and clearly marked to prevent disturbance until planting commences.
During backfilling place slow-release fertilizer tablets 25-30cm deep. For trees the tablets should be located approximately 1.0m from the trunk or adjacent to drip emitters as per site conditions.
- f) Prior to planting tree stakes shall be driven into tree pits.
- g) At the time of planting a hole of size slightly bigger than the root ball shall be made into the pit/bed large enough to take the plants root ball. The planting hole shall be thoroughly watered prior to planting.
- h) Plants shall be carefully removed from containers. Plastic pots shall be split with a knife and plants removed with all the soil intact around the roots. Care shall be taken not to damage the roots or foliage of the plants. The plant shall be placed upright in the hole. Care shall be taken to ensure that the collar line (line of contact between soil and stem) is at the same level as the surrounding ground.
- i) Fill around the plant with planting medium in layers of 150mm, each layer separately firmed to eliminate all air pockets until final soil level is reached.
- j) Trees shall be tied to the tree stakes with tree ties as specified. At least two pairs of ties per tree shall be used but other ties shall be provided if necessary to keep the stem straight. If a leader stake is required, this shall be 20mm round softwood stake slotted inside the tree tie loops.
- k) A circular watering basin slightly larger than the planting hole shall be formed. During and after planting the plants shall be thoroughly watered.
- l) After planting the area surrounding the plant shall be restored to finished grade and excess soils and rubbish disposed of properly.
- m) Immediately after planting all plants are to be pruned in accordance with accepted horticultural practices or as directed by the Architect and Engineer-in-charge. Pruning shall consist of carefully cutting back any damaged, dead or diseased branches and the removal of any weak or malformed growth, with the aim of forming each type of stock to the standard shape for its species. All pruning cuts greater than 20mm shall be treated with a pruning paint as specified.
- n) An aluminium label clearly marked with the Latin name shall be attached to or adjacent to every tenth tree, every twelfth shrub and every fifteenth ground cover.
- o) Monitor all plants after planting for signs of windshake and loosening due to soil subsidence; firm and make good as necessary.
- p) The Contractor shall not add compost and fertilizer to palm pits at the time of planting and until so instructed by the Architect and Engineer-in-charge/Client.

7.8.2 Percolation test procedure:

- a) One day prior to the test the pit/bed shall be filled with water.
- b) A marker bar is placed in the pit/bed before the test is performed
- c) The pit/bed is half filled with water and the level is indicated with tape on the marker bar.
- d) The test is monitored over a period of one hour. If the water level drops by 20mm or more within that time the pit/bed passes.



- e) If a pit/bed fails the percolation test, boreholes shall be augured (2 no/tree pit or 10m spacing in planting beds).
- f) Tests should be repeated until a satisfactory result is achieved.
- g) After auguring the boreholes shall be capped with wire gauze.
- h) Percolation tests shall be carried out at a rate of 1 test per 50 plants. The Architect and Engineer-in-charge / Client may instruct additional tests on an exploratory basis in the event of unsatisfactory percolation being evident.

7.8.3 Planting pits:

- a) Size of planting pit shall be as follows:

1.	Large Tree/palm pit	1.3m x 1.3m x 1.3m
2.	tree pit	1.0m x 1.0m x 1.0m
3.	shrubs/grasses/succulents	0.6m x 0.6m x 0.6m
4.	lawn areas	0.3m minimum depth

7.8.4 Grass Stolons and seeding

The procedure for planting grass stolons shall be as follows:

- a) Prior to beginning planting operations, the irrigation system must be completely operational ensuring 100% coverage.
- b) Bring the water content of the area to be planted to field capacity and allow water to percolate until standing water disappears.
- c) Apply complete fertilizer as specified prior to planting stolons.
- d) Cultivate to a depth of 200mm.
- e) Keep dry dormant stolons refrigerated 0-3°C, until the area to be planted is prepared. Do not exceed two weeks of refrigeration. Soak stolons in water after removing from cold storage and prior to planting.
- f) Do not exceed two days of storage on job site. Stolons are to be kept moist, shaded and ventilated during such storage.
- g) Plant during the time of year when daytime temperatures do not exceed 38°C and night time temperatures are not below 15°C. Mean temperature should exceed 26°C. Water within 15 minutes of planting at 38°C, 30 minutes at 28°C, 60 minutes at 21°C, and 120 minutes at 16°C.
- h) Sow at 200litres per 100 square meters.
- i) Plant utilizing a disc to cut in stolons and followed by a culti packer roller, or other technique approved by the Architect and Engineer-in-charge.
- j) Water as necessary to keep the stolon bed moist until germination. Once grass is up begin lengthening intervals between irrigation.

7.9 Mowing Strips

- 7.9.1 The Contractor shall install mowing strips as per Detail drawings.

8.0 COMPLETION AND MAINTENANCE

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- 8.1 Substantial Completion
- 8.1.1 At the date of Substantial Completion all plants shall be in their specified position and condition.
- 8.2 Plant Establishment Period
- 8.2.1 The Plant Establishment Period shall be for three months from the date of Substantial Completion and may run consecutively with the three Year Maintenance Period. Any plant material not showing acceptable levels of growth shall be replaced by the Contractor who shall bear all the associated costs.
- 8.3 Failure of Plants
- 8.3.1 Any plants that are found to be missing, defective or not in good condition at any time during the contract period and maintenance period shall be immediately replaced by the Contractor, who shall bear all the associated costs.
- 8.4 Maintenance Period
- 8.4.1 **The Maintenance Period shall run for a period of three calendar year (3 year) from the date of Substantial Completion of the whole of the Works.**
- 8.4.2 The Contractor shall maintain insurances of relevant items as required by the Contract throughout the Maintenance Period.
- 8.4.3 The contractor shall carry out maintenance of the planting strictly in accordance with the Operations and Maintenance manual as approved by the Client. The Contractor is to provide all required labour, plant and materials to comply with the approved procedures.
- 8.4.4 During the Maintenance period the Contractor shall make adequate provision for irrigation and/or operate the irrigation system as required and maintain same for handover to the Client on completion of the Plant Establishment Period, comprehensively overhauled and in perfect working order.
- 8.4.5 The contractor shall keep necessary number of personnel (gardeners, labourers, irrigation supervisor) in proper uniform, full time at site, and shall be required to send additional manpower as and when required to carry out special maintenance works like removing dry palm fronds, aeration, planting seasonal, replacing trees and all the treatments required for plant protection.
- 8.4.6 A qualified and experienced agricultural engineer, approved by the Client, shall be required to inspect the site regularly for correct diagnosis of pests or diseases and to take timely remedial measures.
- 8.4.7 An experienced plumber will be deputed to the site on regular intervals to check the irrigation system and adjust/replace the equipment that is not working properly. Seasonal adjustments to the irrigation operation schedule and programming of controllers shall be done by a qualified irrigation engineer, prevailing according to the weather conditions and Client's requirements.
- 8.4.8 The contractor shall maintain, at all times, sufficient stock of regularly utilized fertilizers, chemicals, tools, spare parts and other consumables at site.
- 8.4.9 Trimmings, cut branches, dry leaves and other waste shall be removed daily from the site and disposed of in the Municipality dump.
- 8.4.10 The site shall be kept neat, tidy and in good condition at all times.
- 8.4.11 In the case of any horticultural staff designated by the Client, the Contactor shall fully train such staff for the duration of the Maintenance Period at no additional cost.

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8.5 Operations and Maintenance Manual

8.5.1 The Contractor shall compile a comprehensive Operations and Maintenance Manual which will include the following:

- a) Pesticide/fungicide/herbicide applications - including safety application rates and procedure, schedules of pesticides/fungicides/herbicides.
- b) Water application rates and maintenance procedures, including a detailed description of Irrigation and Storm water drainage methods.
- c) Fertilization - including fertilizer descriptions, application rates and programs.
- d) Salinity Control - including leaching methods and leaching program monitoring.
- e) Turf Grass Management - including mowing procedure, replacement of turf grass by stolon and sods and routine management procedures; aeration, top dressing, vertical mowing, thatch removal, cleaning, rolling and over seeding.
- f) Propagation and replacement of seasonal flowers every 3 months maximum or when deemed necessary.
- g) General Maintenance Monthly Operations Schedule - including pruning, stakes and ties, berm work, replacement and clean-up, protective fencing etc.
- h) Equipment Inventory, maintenance procedures and full manufacturers maintenance manual.
- i) Personnel

8.5.2 The Operation and Maintenance Manual for Soft Landscape shall be submitted to the Architect and Engineer-in-charge/Client by the Contractor for approval at least three months prior to the date for Substantial Completion of any part of the Works and must be approved prior to the commencement of the Plant Establishment Period. Three bound copies of the manual in A4 format shall be presented to the Client.

9.0 REFERENCES

9.1 Standards

9.1.1 The following Standards are referred to in this specification:

- i. Pest Management in Horticultural crops, IIHR Bangalore
- ii. Proceeding of the National consultation Seminar on Horticultural Research & Development, IIHR Bangalore
- iii. Neem Cake- An organic formulation for Insect Pest Management in Horticulture, IIHR Bangalore

10.0 SCOPE OF HORTICULTURE MAINTENANCE WORK

10.1. Complete maintenance of the entire horticulture features of the all four street area i.e. lawn, trees, shrubs, hedge, potted plants, flowers beds, creepers etc. and other garden feature including watering hoeing, making of plants basic manuring, trimming and cleaning of hedges / plants, Beds, spraying of insecticides, fungicides, weeding, mowing, and top dressing of lawn with good earth and manure and hedge clipping and removal of the garden waste, composting of green waste from plants, trees, lawn mowing, etc as per direction and satisfaction of the officer-in-charge to maintain the plants, hedge and lawns in good and healthy conditions at all the time during the maintenance period.

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10.2. The following activities are covered under this contract.

Sr. No.	Item of work	Nos./Qty./Frequency Required
(i)	Pruning & trimming of trees/shrubs creepers etc.	Yearly/need base with the permission of forest department
(ii)	Hedges Cutting	Monthly
(iii)	Any other item (Horticulture, Civil, Elect, U/F water supply) required for proper maintenance	On need basis
(iv)	Irrigation	Daily
(v)	(i) Manuring (ii) Fertilization	As per requirement
(vi)	Lawn Moving	Monthly
(vii)	Plant Protection	Need Based
(viii)	Cultivation & Weeding	As and when required
(ix)	Seasonal Flowers	Wherever feasible
(x)	Top dressing with soil &/or manure	Yearly
(xi)	Repair & replacement of plants, levelling etc.	As and when required

10.3. The following conditions shall be followed:

- a. In case of any causality of shrubs, trees or any other plants has been found during maintenance the Agency should replace the trees/ shrubs/ other plants of the same height and specification by another at his risk and cost and nothing extra shall be paid for the same. The decision of the Engineer in Charge shall be final and binding in this regard.
- b. In case, if it is observed that the maintenance is not healthy and to the required standard, no payment shall be made of the specific area for the period over which the maintenance has been found to be neglected. The decision of the Engineer in Charge shall be final and binding in this regard.
- c. The required quantity of insecticides/ Pesticides will be arranged by the agency for proper maintenance (only during the maintenance period) if needed.
- d. The rejected & substandard material should be removed from the site of work immediately; the Department shall not be responsible for any damage/ loss of rejected material. If the same will not be removed within five days after issuing notice in writing by Engineer in Charge.

10.5 In no case the irrigation / watering of plants and greenery should be deprived



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**PREFERRED MAKE LISTS**

S. No.	Material / Item	Make
	PPC & RCC WORK	
1	Cement (OPC)	UltraTech, Ambuja, JK Lakshmi, JK Cement, Nuvoco Cement, Hathi cement
2	Cement - White	J.K. Cement, Birla White
3	Admixture for Concrete (Plasticizers & Super-Plasticizers, VMA, Mineral Additive)	Sika, Fosroc, Mapei, MYK Arment, Chryso India, STP, Master Builder (BASF), CAC
4	Reinforcement Steel : Main Producers only	TATA (TISCO), SAIL, RINL
5	Anti-Termite Pesticides	Bayer (ENVU- Premise), FMC India, Sumitomo chemical,
6	Expansion Filler board-Premoulded compressible (non-Bituminous)	Supreme, STP
7	Ready Mix Cement Concrete	Ultratech, JK Laxmi
8	System Shuttering	PERI, Alsina, RMD Kwikform
9	PVC Pipe	Astral, Prince, Supreme
10	Injection adhesive for rebar	Hilti, Wuerth, Fischer
11	Core cutting machine/ rebaring	Hilti, Fischer, Wuerth
12	Polysulphide Sealant/ PU sealant	Mapei, Sika, Fosroc, Master Builder (BASF), MYK Arment, Ferrouscrete, Bostik
	MASONRY WORK	
13	Brick masonry joint Mortar/ Polymer modified ready mix cement mortar	Xtralite from Ultratech, Magicrete, Aerocon from HIL, Ethios Enviro Soluton Pvt Ltd., JK Laxmi, Eco Green
14	AAC Blocks	Xtralite from Ultratech, Magicrete, Aerocon from HIL, Ethios Enviro Soluton Pvt Ltd., JK Laxmi, Eco Green
15	Glass Brick	Seves, Mulia, SPG
16	DOORS & WINDOWS WORK	

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S. No.	Material / Item	Make
17	Flush door shutter (With pine block board infill) (All flush doors shall be procured from fully owned factory of the manufacturer and not from JV / outsourced)	Mikasa -Decowood, Greenply (Green), Century, Duroply, Archidply
18	Air transfer grill	Ruskin Titus, System Air, Trox, Cosmos
19	Glass	Saint Gobain, AIS, Modiguard (Gujarat Guardian), Sisecam
20	Silicone Sealant	Wacker, Mapei, Bostik, Tremco
21	Compact sheet	Archidply
22	Floor spring, door closer & door automation	Dormakaba, Assa Abloy (except Enox), Hafele, Gaze
23	All type of Door lock including Mortise locks with lever handle	Dormakaba, Assa Abloy (except Enox), Geze, Hafele, Godrej
24	SS 304 Door Hardware (other than Floor spring, Closer, Locks)	Dormakaba, Assa Abloy (except Enox), Geze, Hafele, Ozone, Godrej
25	Concealed automatic drop-down seal/ Acoustic Seal / or any other type of Door seal	Athmer, Raven, Dormakaba, Lorient, Kilargo, Hafele, Hormann
26	Anchor/fasteners	Hilti, Fischer, Wuerth
27	Laminates and compact laminate sheet	Greenlam, Merino, Royal Touche
28	Mirrors/ interior mirror (superior quality crystal clear)	Saint Gobain, Modi Guard, Asahi India Glass Ltd., Sisecam
29	Polyester Powder coating/ PVDF Coating	Jotun, AkzoNobel, Asian PPG
30	Structural Silicon sealant, Pre pigmented Weather Silicone	Tremco, Wacker, Bostik, Mapei
31	Wood Adhesive	Fevicol, Araldite, Kerakol
32	Brass Hardware	Magnum, EPPW
	WATER PROOFING WORK	
33	Water Proofing compound	Fosroc, Sika, Master Builder (BASF), Mapei, MYK Arment
34	Water proofing membrane (PVC/ HDPE)/ Water proofing coating (PU/ Polyurea/ Acrylic/ Elastomeric cementitious)	Fosroc, MYK Arment, SIKA, Master Builder (BASF), Mapei

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S. No.	Material / Item	Make
	FLOORING WORK	
35	Vitrified Tiles (All tiles shall be procured from fully owned factory of the manufacturer and not from JV /outsourced)	Restile, Kajaria, H&R Jhonson, Simpolo, RAK
36	Tiles/ Stone fixing Adhesive (Only High performance, polymer modified, non-slip adhesive)	MYK- Latricrete, Saint Gobain-Weber, Ferrouscrete, Ardex Endura, Kerakoll, Mapei, Fosroc
37	Epoxy Grout/ Cementitious Grout for Flooring	Ardex Endura, MYK- Latricrete, Saint Gobain-Weber, Ferrouscrete, Kerakoll, Mapei
	METAL WORK	
38	Stainless Steel	SAIL, Jindal, TATA
39	Structure Steel & Hollow Section	SAIL, TATA (TISCO), RINL, Jindal Steel & Power (JSPL), APL Apollo tube, JSW
40	Steel (MS) rolled section & plate	TATA, Jindal , SAIL, RINL
41	Aluminium sections and plates (Other than modular/system aluminium products for partitions, windows and curtain wall)	Hindalco, Jindal, Boruka, Balco,
42	Anchor Fastener, Rebar, Chemical/ Mechanical fastener, Expandable fasteners	Hilti, Fischer, Wuerth, AFT
43	Non shrink cementious precision (anchoring) grout	Fosroc, Sika, Mapei, MYK Arment
44	Cold rolled section (CRS) for framing	TATA, Bhusan Steel, JSW, SAIL, APL Apollo
45	Roofing system/ Sandwich panels for roofing	Kingspan
	WALL PANELLING WORK	
46	Urinal Partitions	Greenlam, Merino
47	Modular Toilet Cubical	Greenlam, Merino
48	Plywood (All plywood shall be procured from fully owned factory of the manufacturer and not from JV / outsourced)	Mikasa -Decowood, Greenply (Green), Century, Duroply, Archidply

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S. No.	Material / Item	Make
49	Rock wool/ Glass wool Insulation	UP Twiga, Rockwool India, Roxul Rockwool India, Lloyd, Siderise
50	Veneer	Mikasa -Decowood, Greenply (Green), Century, Duroply, Archidply
	FALSE CEILING WORK	
51	12.5 mm thick Fire resistant Glass Reinforced Gypsum (GRG) Boards Ceiling	Saint Gobain, USG Boral, Knauf Danoline
52	12.5 mm thick perforated gypsum boards	Saint Gobain, USG Boral, Knauf Danoline
	PAINTING WORK	
53	White cement-based putty	Birla, JK, Asian paints, Berger
54	Paint - Plastic Emulsion (Internal)	Asian paints, Berger Paints, Jotun, Akzo Nobel (Dulux), Narolac
55	Paint - Synthetic Enamel	Asian paints, Akzo Nobel (Dulux), Berger Paints, MRF, Narolac
56	Paint - Acrylic Emulsion (Exterior)	Asian Paints, Akzo Nobel (Dulux), Jotun, Berger, Narolac
57	Paint - PU & epoxy paint and primer	ICA, Asian paints, Akzo Nobel (Dulux), Berger, Jotun, Nippon, MRF, Narolac
58	Stain-repellent transparent coating	Killick Guard, Dow-corning, Akemi, Wacker
59	PU Polish for woodwork	ICA, Akzo Nobel (Dulux), Asian paints, Berger, MRF, Narolac
60	Stonecrete type plaster/ Exterior Texture	Vyara
61	Exterior Texture	Heritage, Earthen, SKK
	EXTERNAL DEVELOPMENT WORK	
62	Precast Planter/bench	Vyara, TDW , PSP Projects & Proactive Con Pvt. Ltd.
63	SS recessed manhole cover	Lidco
64	FRP Recessed Manhole cover	Himalaya, Amrock, Fibrocast
65	Precast Concrete elements (light pole cover, base of dustbin, coping, and other similar elements)	Vyara, Winner conmat, Super, PSP project and proactive construction

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Note:

1. The grouping of various items in above table is only for convenience purpose
2. Preferred makes for items shall be applicable anywhere in the contract work.
3. All materials and products shall conform to the relevant standards (IS, EN, BS, ASTM, ISO, AS/NZS) and shall be of approved make and design.
4. The Engineer-in-charge shall give the approval of a make of material to be used for the work only after review of the sample/ mock-up. In case the same is not available in the market or in case of change in trade name or renaming of manufacturer then an equivalent approved make shall be used with the approval of Engineer-in-charge.
5. Engineer-in-charge reserves the right to select any of the preferred make from the above list.
6. Only "First" class quality materials shall be used.
7. Specification of manufacturer's item shall be checked against BOQ item and specifications before selecting any product or brand name. In case of any discrepancy, BOQ item/ specifications shall prevail.
8. In case of any item/ product neither covered in this list nor having a BIS specification, the contractor shall submit the proposed item/ product along-with technical details/ specifications (as per bid), test certificates etc. and other credentials of the manufacturer for approval by Engineer-in-charge.



**TECHNICAL SPECIFICATIONS
(ELECTRICAL WORKS)**



ELECTRICAL MATERIAL SPECIFICATION

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E-1 DISTRIBUTION BOARDS

1.1 Scope :

It includes Supply, Installation, Testing and Commissioning of Distribution Boards standard company fabricated or to be fabricated by fabricator.

1.2 Standards :

IS : 8623 : 1 & 3 and IEC 61439 1 & 3 Distribution Boards

1.3 Distribution Boards :

- a) Distribution boards along with the controlling MCB's/Fuse or Isolator as shown shall be fixed in an M.S. Box with hinged door suitable for recessed mounting in wall. Distribution boards shall be made of minimum 18 SWG steel sheet duly rust inhibited through a process of de-greasing, acid pickling, phosphating and powder coated to an approved colour of adequate micron rating duly approved by architect/consultant.

Three phase boards shall have phase barriers and a wire channel on three sides. Neutral bars shall be solid tinned copper bars with tapped holes and chase headed screws. For 3 phase DB's, 3. independent neutral bars shall be provided for per phase isolation in addition to main neutral links.

- b) 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. The top and bottom side of DB should be detachable.
- c) All DB's shall be internally pre-wired using copper insulated Busbars of appropriate rating. Bus bars shall be suitable for the incoming switch rating and sized for a temperature rise of 35° C over the ambient. Each board shall have two separate earthing terminals. Circuit diagram indicating the load distribution shall be pasted on the inside of the DB as instructed. Two earthing terminal for single phase and two terminals for 3 phase DB's shall be provided with one earth strip connecting the studs and the other earth link should be provided with base insulator in such a way that link should in contact with body of distribution board.

1.4 RCCB/RCBO:

- a) The RCCB should suffices all the requirements of IS as per code IS - 12640 (Part I) – 2000 and IEC 61008-1. The RCBO should suffices all the requirements of IS as per code IS - 12640 (Part 2) – 2000 and IEC 61009-1. The RCCB and RCBO should be current operated and not on line voltage.
- b) The RCCB/RCBO should ensure mainly the following functions.
- 1) Measurement of the leakage & fault current value.
 - 2) Comparison of the Leakage & fault current with a reference value.
- c) The RCCB/RCBO should have a toroidal transformer witch has the main conductors of primary (P - N) which check the sum of the current close to zero. All metal parts should be inherently resistant to corrosion and treated to make them corrosion resistant. It should be truly current operated. It should operate on core balance toroidal transformer. It's accuracy should be $\pm 5\%$. It should operate even in case of neutral failure. It should trip at a present leakage current 30-300 Amp within 30 MS as mentioned in the BOQ .It's enclosure should be as per IP 30. It's mechanical operation life should be more

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than 20,000 operations. It should provide full protection as envisaged by IE rules - 61-A, 71 - ee, 73 - ee, 1985 and also rule 50 of IE rule 1956. It should conform to all national and international standards like IS, BS 4293 - 1983, CEE 27 (International commission Rules for the approved of electrical equipment).

1.5 MCB/ Isolators:

Miniature circuit breakers shall be quick make and break and break type conform with IS :60898-1 and IEC-60947-2. The housing of MCBs shall be heat resistant and having a high impact strength. The fault current of MCBs shall not be less than 10000 amps, at 230 volts. The MCBs shall be flush mounted and shall be provided with trip free manual operating mechanism with mechanical "ON" and "OFF" indications.

The circuit breaker dollies shall be of trip free pattern to prevent closing the breaker on a faculty current. Tightening torque at terminals shall be not less than 2.5 Nm .Power losses should not be more than as specified in IEC 60898-1.

The MCB contact shall be silver nickel and silver graphite alloy and tip coated with silver. Proper arc chutes shall be provided to quench the arc immediately. MCB's shall be provided with magnetic fluid plunger relay 3 as for over current and short circuit protection. The over load or short circuit devices shall have a common trip bar in the case of DP and TPN miniature circuit breakers. All the MCB's shall be tested and certified as per Indian Standard, prior to Installation.

For protection of electric circuits with equipment that does not cause surge current (i.e. lighting and socket outlet circuits)'B' curve MCB to be used in which magnetic releases operates between 3 and 5 In.

For protection of electric circuits with equipment that cause surge current (i.e. inductive and motor circuits) 'C' curve MCB to be used in which magnetic releases operates between 5 and 10 In.

For protection of electric circuits with equipment that cause surge current (i.e. transformer, heavy start motors circuits) 'D' curve MCB to be used in which magnetic releases operates between 10 and 15 In.

Isolators shall confirm to IS 60947-3 and IEC 60947-3.

1.6 SPDs (Surge Protection Devices) shall conforms standard NF C 61-740, IEC ,61643-1 and EN 61643-11

SPDs shall be of Type II for DB level internal Protection (Class S, 8/20 microseconds waveform, UP-1.2KV / 1.4KV, I_{max} 15KA) and DIN-rail type (Unless & otherwise specified).

SPDs shall be suitable for TT, TNC, TNS or TNC-S earthing systems.

SPDs shall provide protection between line to earth (common mode), neutral to earth (common mode) and line to neutral (differential mode).

SPDs shall be of the "withdrawable cartridge" type. The base of the SPDs shall be able to accept cartridges of different discharge ratings of I_{max}: 15kA, 20kA, 40kA & 65kA (8/20 microseconds waveform).

Optional auxiliary contacts for remote indication shall be integrated in the base of the SPDs to eliminate possibility of wrong installation.

SPDs shall limit the transient let-through voltage of not more than 1.4kV in accordance to IEC 60364.

Protection against SPDs short-circuit (in the event of end-of-life of SPDs or/and short circuit at 50hz like neutral disconnection, inversion of Neutral /line,) shall be provided by a dedicated miniature circuit breaker that has been tested to co-ordinate with the manufacturer's SPDs in accordance to IEC 60364.



E-2 MV CABLE LAYING

1.1 Scope :

The scope consists of Supply, laying, testing and commissioning of L.T. XLPE Cable and its termination.

1.2 Standards :

AS PER SCHEDULE OF INDIAN STANDARDS; ATTACHED IN THE DOCUMENT

1.3 Cables :

1100 volt grade XLPE cables

All cables shall be 1100 Volt grade XLPE insulated sheathed with or without steel/GI wire or flat armoring as specified. The cable shall conform to IS-7098, Part I. Cables shall have high conductivity stranded aluminum or copper conductors and cores colour coded to the Indian Standards. All cables laid up to load should be without any joint. All cables shall be new without any kind or visible damage. The manufacturers name, insulating material, conductor size and voltage class shall be marked on the surface of the cable at every 600 mm centers.

Insulation: The core insulation shall be with compound applied over the conductor by extrusion and shall confirm to the requirement of IS-5831.

Core identification shall be provided with prominent and indelible Arabic numerals on the outer surface of the insulation colour as under.

Single core	-	Red, Black, Yellow or blue.
Two core	-	Red and Black.
Three core	-	Red, Yellow, and blue.
Four core	-	Red, Yellow, Blue and Black.
3.5 core	-	Red, yellow, Blue and Black. (Reduced neutral)
Five core	-	Red, Yellow, Blue, Black and Light Grey.

In case of cables having more than 5 cores two adjacent (counting and directional) in each layer shall be coloured Blue and yellow respectively and the remaining cores shall be light grey.

The inner sheath shall be applied over the laid up cores by extrusion and shall be of extruded XLPE compound. Armoring shall be applied over the inner sheath. Armour shall be of galvanized round steel wires up to the cable diameter of 13 mm and above 13 mm galvanized flat steel wires shall be provided. Requirement and methods of tests for armoured material and uniformity of galvanism shall be as per IS-3975 and IS -2633. The outer sheath for the cables shall be applied by extrusion and shall be of PVC compound confirming to the requirement of compound of IS-5831 for protection of the cable against atmospheric effect. Pollution rodent and termite attack suitable chemical shall be added in PVC compound. Colour shall be black.

Testing and Inspection: All the cables shall be tested and examined at the manufacturer work. All the materials employed in the manufacturing of cable shall be subject to examination and testing after manufacture of cable. All routine and acceptance tests in accordance with the relevant standard shall be conducted on each size of cables and shall be submitted to client at the time of hand over.

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Packing and Marking: Cables shall be dispatched in wooden drums of suitable barrel diameter, securely battened with the take off end fully protected against mechanical damage. The wood used for construction of the drum shall be properly seasoned. Sound and free from defect. Wood preventative shall be applied to the entire drum. On flange of the drum, necessary information such as manufacturers name, type, size, voltage grade of cable, length of cable in meters, drum no., cable code, ISI certification mark gross weight etc. shall be printed. An arrow shall be printed on the drum with suitable instructions to show direction of rotation of the drum. Cable shall be supplied in drum length as follows.

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E-3 M V Cable Termination :

1.1 Connectors :

Cable terminations shall be made with copper/Aluminum Heavy duty long neck copper crimping lugs only crimped type solderless lugs for all aluminum cables and stud type terminals. For copper cables copper crimped solderless lugs shall be used.

Crimping shall be done with the help of hydraulically operated crimping tool. All cable lugs should be long neck type only.

1.2 Cable Glands :

Cable glands shall be of heavy duty brass single compression type as specified. Generally single compression type cable glands shall be used for indoor protected locations and double compression type shall be used for outdoor locations. Glands for classified hazardous areas shall be CMRS approved.

1.3 Ferrules:

Ferrules shall be of self sticking type and shall be employed to designate the various cores of the control cable by the terminal numbers to which the cores are connected, for ease in identification and maintenance.

1.4 Cable joints:

Kit type joint shall be done and filled with insulating compound. The joint should be for 1.1 KV grade insulation.



E-4 CABLE TRAY & RACE WAY

1.1 Cable Tray System

The cable tray shall be supplied in convenient lengths and assembled at site to the desired lengths along with all required accessories and supports from same manufacturer. Cable tray systems shall be so designed and so constructed that in normal use, when installed according to the manufacturer's or responsible vendor's instructions, they ensure reliable support to the cables contained therein. They shall not impose any unreasonable hazard to the user or cables. Type test certificate for each size and its accessories are to be provided in compliance as per IEC 61537. This type test certificates should be provided from NABL accredited third party labs only.

The maximum permissible uniformly distributed load for various sizes cables trays and for different supported span shall be considered as per CPWD specifications. Load for future cables and empty spaces to be also considered while designing supports. However minimum two supports for each standard length shall be provided. A third-party load test certificate conducted at reputed labs are to be provided in compliance of loading capacity each typical size as specified in BOQ.

The width of the cables tray shall be chosen so as to accommodate all the cables in one tier, plus min. 30% additional width for future expansion. The overall width of one cable tray shall be limited to 900mm.

The cable tray shall be suspended from the ceiling slab or side walls or as required with the help of required supports. Supports are to be made of minimum 10 mm dia continuous threaded GI round or as per requirement as instructed by engineer in charge. In case more than one tray are required to be installed in multi-tier formation, supports and clamps are required to be provided as per actual load calculation as required. Round suspenders shall be threaded and bolted to the cable trays or to independent support angle 50 mm x 50 mm x 5mm at the bottom and as specified. These shall be grouted to the ceiling slab including required anchor fasteners at the other end through an effective means, as approved by the Engineer in charge, to take the weight of the cable tray with the cables. Load for future cables and empty spaces to be also accounted while designing supports.

Each system component shall be durably and legibly marked with the manufacturer's or responsible vendor's name or trademark or identification mark and a product identification mark which may be, for example, a catalogue number, a symbol, or the like as suggested by engineer in charge.

The manufacturer shall provide in his literature all information necessary for the proper and safe installation and use of the cable tray system, The SWL and impact resistance is valid for the whole temperature classification declared. The information shall include instructions for the assembly and installation of system components and for the precautions required to avoid excessive transverse deflection, which could cause damage to the cables. The appropriate material specification and environmental conditions, chemical environments, or aggressive agents for which the product is suitable for.

Safe Working Load (SWL): Cable tray systems are suitably designed to carry the maximum permissible uniformly distributed load in Kgs. per running meter for different unsupported free spans are as per CPWD specification. Cable tray systems shall provide adequate mechanical strength to carry the maximum permissible uniformly distributed load.



The main criterion for the SWL is safety in use of the product. For the declared application, the manufacturer shall declare the SWL to be tested. Following details are required to provide however not limited to this only.

- SWL in Kg/Mt for the cable tray lengths including joints, where applicable for one or more installation methods as required. i.e., mounted in the horizontal plane running horizontally on multiple spans.
- SWL in Kg/Mt for the fittings when not directly supported and the distance Y from the supports adjacent to the fittings.
- SWL in Kg for cantilever brackets and if used for cable tray only.
- SWL for pendants as a bending moment in Kg/mt and/or as a force in Kg
- Safety Factor : Load test with applying 1.7 times SWL. The sample shall sustain this increased load without collapsing. Buckling and deformation of sample are permissible at this loading.

Compliance for cable tray for SWL is to be provided by carrying out the relevant tests as per IEC 61537 on samples of the widest and narrowest width for each product type. The deflection of cable tray must be no more than 1/100th of the distance between two supports and tested in accordance with the standard IEC 61537. For the intermediate widths, the SWLs shall then be determined by interpolation of the test results.

Cable tray systems shall have adequate electrical continuity to ensure equipotential bonding and connection(s) to earth if required according to the application of the cable tray system. The calculated impedances shall not exceed 50 mohm across the joint and 5 mohm per meter without the joint as per IEC61537. All system components shall have adequate resistance against corrosion.

A Perforated Cable Tray and its Accessories

The cable tray and its accessories shall be fabricated out of single slotted / perforated MS sheets with single or double bended. These sections shall be hot dipped galvanized as specified made of 1.6mm / 2.0mm thick MS perforated sheet as specified in BOQ. Overall Perforation shall not more than 17.5% and Galvanization thickness should not be less than 50 microns to be provided. Each section of standard length is to be manufactured from single sheet and should not be welded / bolted out of multiple sheets. The jointing between the sections shall be made with coupler plates of the same material and thickness as the channel section. Two coupler plates, each of minimum 200mm length, shall be bolted on each of the two sides of the channel section with 8mm dia round headed bolts, nuts and washers. Each such coupler plates are to be provided with minimum eight slotted holes. In order to maintain proper earth continuity bond, the paint on the contact surfaces between the coupler and cable tray shall be scraped and removed before the installation if provided.

Factory fabricated bends, reducers, tee / cross junction etc. shall be provided as per good engineering practice. The radius of bends, junctions etc. shall not be less than the minimum permissible radius of bending of the largest size of cable to be carried by the cable tray. The entire cable tray and all accessories like couplers, bend, Tee, Threaded rod or Flats for suspension, base support angel etc. shall be hot dipped galvanized. The cable tray shall be bonded to the earth terminal at both ends. The cable tray shall be measured on unit length basis, along the center line of the cable tray, including bends, reducers, tees, cross joints, all kind of supports etc., and paid for accordingly.

1.2 Raceways and Junction Boxes

Underfloor systems intended for the support and accommodation of Power, Data and Multi-media cables required for electrical / Communication systems made out of pre-galvanized sheet (DX51D) with minimum thickness of 1.6 mm and coated with minimum 275 GSM.

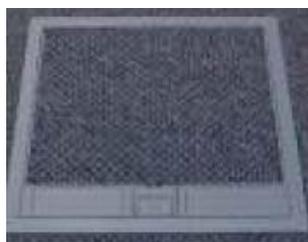
- 1.2.1** GI raceways made of pre-galvanized sheet with thickness of 1.6 mm for lid, base & Partition between compartments for distributing LV and ELV cabling in screed floors installations. Raceway should be rectangular formed with top & bottom

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plates double folded and spot / mig welded together to provide the rigidity and at the same time to prevent seepage of concrete or screed water. Partition between two compartment should be continuous and to be properly spot / mig welded at bottom level. Aluminum painting / zinc paint should cover all the welding spots to avoid corrosion. Raceway should be suitable to combined with junction boxes, backboxes (floor boxes) for wiring devices, Raceway should be provided with all fixing and coupler accessories as required. Protection level should be min. IP 42 & IK 08. Raceway and all accessories should be provided in compliance and confirmation to standard EN 50 085 - 2 - 2 . Resistance to vertical load applied through small surface area should be 1500 N & Resistance to vertical load applied though largesurface area should be minimum 3000 N. Race ways should be supplied with complete accessories i.e. fixing brackets & couplers for joining raceways from the same manufacturer.



- 1.2.2** Junction boxes for direct access to cables at the intersection of raceways. Supply completely with base and cover plate (Lid) with height adjustable feature from 50 mm to 80 mm or 60mm to 75mm or 65mm to 90 mm as per manufacturer standard. All size & type of junction boxes, cross over boxes etc. as per BOQ & should be provided in compliance & confirmation to standard EN 50 085 - 2 - 2. For adjustable junction box, resistance to vertical load applied should be min. 5000N. Use junction box with fly over for direct access to cables at the intersection of floor raceways while maintaining perfect separation and 90 degree cross overs between data and power cables. Junction box should be made out of 1.6mm thick 275 GSM pre-galvanized sheet & LID should be min. 2.00 mm thick 275 GSM pre-galvanized sheet. Junction box should be min. IP20. Raceways and junction boxes should be supplied with complete accessories i.e. fixing brackets & couplers for joining raceways from the same manufacturer. Cover of raceway should be fixed either by 4 nos. of screws on support or with hinged facilitate frame as per requirement or informed by engineer in charge. Access outlet facility to mount switch, socket with ELV accessories also to be provided if required or informed by engineer in charge.





1.2.3 On wall trunking & its all finishing accessories (end, joint of lid, joint of body, interior angle, exterior angle, flat angle, derivation) shall be made with PVC DLP & as per confirming standard EN 50085-2-1. Trunking should accept Wiring device with all the functions by associating the accessory of installation. Trunking should confirm to the current specifications of NF C 68-104 in terms of both performance and level of functions provided by the system. Installation trunking (which carries electrical wiring accessories) should be type 3 (installation) in the new standard. Material should be Non-flame propagating. Degrees of protection provided by enclosure should be IP 40. Protection against mechanical impact should be IK 07. The trunking covers and partitions should be in PVC white RAL 9003. The accessories should be in plastic ABS white RAL.



E-5 INTERNAL WIRING

1.1 Scope :

The scope covers supply, laying, testing and commissioning of wiring in rigid metallic conduits , Switches, master switches, Sockets and accessories

1.2 Standards :

AS PER SCHEDULE OF INDIAN STANDARDS, ATTACHED IN THE DOCUMENT

1.3 Rigid and Flexible conduits :

A) All rigid conduits shall be steel and ISI marked & I.S.I. All rigid pipe and its accessories shall be of suitable material complying with IS:9537 (Part 2)1981 and IS :9537 (Part 5) 2000 for flexible conduits. The conduits shall be circular in cross-section and designated by their nominal outside diameter. Minimum thickness of walls shall be as follows. The conduits shall be circular in cross-section and designated by their nominal outside diameter . Minimum thickness of walls shall be as follows:

- a) Upto 38 mm. diameter - minimum 1.8 mm. wall thickness.
- b) Above 40 mm. diameter - minimum 2.2 mm. wall thickness.

The maximum number of PVC insulated copper conductor cables of 650/1100V grade conforming to IS:694-1990 that can be drawn in one conduit of various sizes shall be as specified in Table 1 . Conduit size shall be selected accordingly in each run.

No steel conduit less than 25 mm in diameter shall be used.

B) Flexible conduits shall be formed from a continuous length of spirally wound interlocked steel strip with a fused zinc coating on both sides. The conduit shall be terminated in brass adapters.

1.4 Accessories :

- A) The conduit wiring system shall be complete in all respects including their accessories.
- B) The conduit accessories shall be threaded type ,and circumstance pin grip type or clamp grip type accessories shall be used.
- C) Bend, Couplers etc. shall be solid type in recessed type of work and may be solid or inspection type as required, in surface type works.
- D) Saddles for surface conduit work on wall shall not less than 0.55 mm (24 gauges) for conduit up to 25 mm dia. and not less than 0.9 mm (20 gauges) for larger diameter. The corresponding widths shall be 19 mm & 25 mm.
- E) The minimum width and the thickness of girder clips used for fixing conduits to steel joists, and clamps shall be as per below table.

Size of Conduit	Width	Thickness
(i) 20 mm	19 mm	0.9 mm (20 SWG)

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(ii) 25 mm	19 mm	0.9 mm (20 SWG)
(iii) 32 mm & above	25 mm	1.2 mm (18 SWG)

1.5 Wires :

- A) All wires shall be single core multi-strand/ flexible copper or single strand Copper FRLS type PVC insulated as per IS:694 and shall be 660 V\1100 V grade.
- B) All wires shall be colour coded as follows :

<u>Phase</u>	<u>Colour of wire</u>
R	Red
Y	Yellow
B	Blue
N	Black
Earth	Green (insulated)
Control (If any)	Grey
All off wires	Same as Phase wire

- C) Both end of wires should be terminated with adequate size copper crimping type lugs and ferrules as per instructions of engineer in charge.

1.6 Outlets switches & Sockets :

- A) Switches shall be moulded plate type flush modular type with silver-coated contacts. Sockets shall be multipin pin with switch and plate type cover. Combination of multiple switch units and sockets should be used to minimize the switch boxes. All screws shall be brass – chromium plated and shall be counter sunk type with half round head or flat headed.
- B) For heavy duty, metal clad sockets with M.C.B/ Isolator mounted in a galvanized steel box shall be provided.
- C) The switch boxex shall be made of either rigid PVC moulding or mild steel or cast iron on all sides except at the front. PVC boxes shall comply with the requirements laid down in IS :14772-2000. These boxes shall be free from internal roughness. Wall thickness of PVC boxes shall not be less than 2 mm.Clear depth of the box shall not be less than 60 mm and this shall be increased suitably as per requirements. An earth terminal with stud and washer shall be provided in each MS boxes for termination of protective conductors.
- C) All the fan boxes shall be of cast iron type only with minimum wall thickness of 3 mm.
- E) Switches shall be antic type with silver-coated contacts. Sockets shall be multipin pin with antic type switch and cover.

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1.7 Installation :

1.7.1 Common Aspects for Recessed and Surface Conduit Works

1.7.1.1 Conduit Joints

- A) The conduit work of each circuit or section shall be completed before the cables are drawn in.
- B) Conduit pipes shall be joined by means of screwed couplers and screwed accessories only. Threads on conduit pipes in all cases shall be between 13 mm to 19 mm long, sufficient to accommodate pipes to full threaded portion of couplers or accessories.
- C) Cut ends of conduit pipes shall have no sharp edges, nor any burrs left to avoid damage to the insulation of the conductors while pulling them through such pipes.
- D) The Engineer-in-charge, with a view to ensuring that the above provision has been carried out, may require that the separate lengths of conduit etc., after they have been prepared, shall be submitted for inspection before being fixed.
- E) No bare threaded portion of conduit pipe shall be allowed, unless such bare threaded portion is treated with anti corrosive preservative or covered with approved plastic compound

1.7.1.2 Bend in Conduits

- A) All necessary bends in the system, including diversion, shall be done either by neatly bending the pipes without cracking with a bending radius of not less than 7.5 cm, or alternatively, by inserting suitable solid or inspection type normal bends, elbows or similar fittings, or by fixing cast iron inspection boxes, whichever is most suitable.
- B) No length of conduit shall have more than the equivalent of four quarter bends from outlet to outlet.
- C) Conduit fittings shall be avoided as far as possible on conduit system exposed to weather. Where necessary, solid type fittings shall be used.

1.7.2 Fixing conduits in chase

The conduit pipe shall be fixed by means of staples, J-hooks, or by means of saddler, not more than 60 cm apart or by any other approved means of fixing. All threaded joints of conduit pipes shall be treated with some approved preservative compound to secure protection against rust.

1.7.3 Fixing conduits in RCC work (slab / wall / floor etc)

The conduit pipes shall be laid in position and fixed to the steel reinforcement bars by steel binding wires before the concreting is done. The conduit pipes shall be fixed firmly to the steel reinforcement bars to avoid their dislocation during pouring of cement concrete and subsequent tamping of the same. Fixing of standard bends or elbows shall be avoided as far as practicable, and all curves shall be maintained by bending the conduit pipe itself with a long radius, which will permit easy drawing in of conductors. Location of inspection/ junction boxes in RCC work should be identified by suitable means to avoid unnecessary chipping of the RCC slab subsequently to locate these boxes. At either Side of the bends, saddles/staples shall be fixed at a distance of 15 cm from the center of the bends.

1.7.4 Fixing of inspection boxes

As far as possible inspection boxes shall be avoided or to be minimized as much as possible. If necessary suitable inspection boxes to the minimum sizes shall be provided to permit inspection and to facilitate replacement of wires with prior approval of engineer in charge. These shall be mounted flush with the wall or ceiling concrete with minimum depth of 65 mm for slab and as per IS : 2667 – 1988 for other places.

1.7.5 Fish Wire

To facilitate subsequent drawing of wires in the conduit, GI fish wire of 1.6mm /1.2mm (16/18 SWG) shall be provided along with the laying of the recessed conduits.

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**1.7.6 Earthing**

A protective earth conductor shall be drawn inside the conduit in all distribution circuits to provide for earthing of non current carrying metallic parts of the entire installation. These shall be terminated on the earth terminal in the switch boxes, and/or earth terminal blocks at the distribution boards. Gas or water pipes shall not be used as protective conductors (earth medium). Every sub main will have earth continuity conductor to run along with sub main wiring. Every circuit will have its earth continuity conductor to run along with circuit wiring. In case of 3 phase sub main wiring two earth continuity conductor shall be provided.

1.8 Additional requirements**1.8.1 Fixing Conduit on Surface**

- A) Conduit pipes shall be fixed by saddles, secured to suitable approved plugs with screws in an approved manner at an interval of not more than one meter, but on either side of the couplers or bends or similar fittings, saddles shall be fixed at a distance of 30 cm from the center of such fittings.
- B) Where conduit pipes are to be laid along the trusses, steel joists etc. the same shall be secured by means of saddles or girder clips or clamps as required by the Engineer-in-charge.
- C) In long distance straight run of conduit, inspection type couplers at reasonable intervals shall be provided, or running threads with couplers and jam nuts shall be provided.

1.8.2 Making Chase

The chase in the wall shall be neatly made and of ample dimensions to permit the conduit to be fixed in the manner desired. Chase shall be done with machine cutter only. In the case of building under construction, the conduits shall be buried in the wall before plastering and shall be finished neatly after erection of conduit with wire mesh. In case of exposed brick/ RCC work, special care shall be taken to fix the conduit and accessories in position along with the building work.

Table 1**Maximum Number of PVC Insulated 650/1100 V grade Aluminium / Copper Conductor Cable conforming to IS 694 : 1990**

Nominal cross-sectional area of conductor in sq.mm	20 mm		25 mm		32 mm		38 mm		51 mm		64 mm	
	S	B	S	B	S	B	S	B	S	B	S	B
1	2	3	4	5	6	7	8	9	10	11	12	13
1.50	5	4	10	8	18	12	-	-	-	-	-	-
2.50	5	3	8	6	12	10	-	-	-	-	-	-
4	3	2	6	5	10	8	-	-	-	-	-	-
6	2	-	5	4	8	7	-	-	-	-	-	-
10	2	-	4	3	6	5	8	6	-	-	-	-
16	-	-	2	2	3	3	6	5	10	7	12	8

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25	-	-	-	-	3	2	5	3	8	6	9	7
35	-	-	-	-	-	-	3	2	6	5	8	6
50	-	-	-	-	-	-	-	-	5	3	6	5
70	-	-	-	-	-	-	-	-	4	3	5	4

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E-6 LIGHT FIXTURES AND FANS

1.1 Scope :

The scope covers Supply, installation, testing and commissioning of different types of LED light fixtures, ceiling fans and exhaust fans.

1.2 Standards :

AS PER SCHEDULE OF INDIAN STANDARDS.

1.3 Type of fixtures :

1.3.1 General Requirement: All the light fixtures shall be with LED source only unless specified otherwise.

- 1.3.1.1 All fixtures shall be complete with accessories necessary for installation whether so detailed under fixture description or not.
- 1.3.1.2 Fixture housing, frame or canopy shall provide a suitable cover for the fixture outlet box or fixture opening.
- 1.3.1.3 Fixtures shall be installed at mounting heights as detailed on the drawings or instructed on site by the Architects/Consultants.
- 1.3.1.4 Fixtures and/or fixture outlet boxes shall be provided with adequate support to take 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.
- 1.3.1.5 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. If required, necessary arrangement to be made above false ceiling to cover the light fixture to restrict the light spread inside the ceiling as suggested by architect/Consultant.
- 1.3.1.6 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.
- 1.3.1.7 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.
- 1.3.1.8 Wiring within the fixture and for connection to the branch circuit wiring shall be not less than 1.0/1.5 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.
- 1.3.1.9 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.
- 1.3.1.10 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.
- 1.3.1.11 Non-reflecting surfaces such as fixture frames and trim shall be finished in baked enamel paint.
- 1.3.1.12 Light reflecting surface shall be finished in baked white enamel having a reflection factor of not less than 80%. All parts of reflector shall be completely covered by finish and free from irregularities. After finish has been applied and cured, it shall be capable of withstanding a 6 mm radius bend without showing sign of cracking, peeling or loosening from the base metal. Finish shall be capable of withstanding 72 hours 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 lot of fixtures.
- 1.3.1.13 Fixture with visible frames shall have concealed hinged and catches. Pendant fixtures and lamp holders shall be provided with ball type Algiers or similar approved means. Recessed fixtures shall be constructed so as to fit into an acoustic tile ceiling or plaster ceiling without distorting either the fixture or the 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 prevent the diffuser from moving.

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1.3.1.14 Detailed catalogue cuts for all fixtures, and sample fixtures shall be submitted for approval to the Architect/Consultant before orders for the fixtures are placed. Shop drawings for non-standard fixture types shall be submitted for approval to the Architect/Consultant. Moke-up/sampling to be done at site for each typical installation by contractor for approval prior to order. No separate charge will be paid for nay such sampling at site.

1.3.1.15 Recessed fixtures shall be constructed so that all components are replaceable without removing housing from the ceiling.

- 1) Lamps 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 lighting 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.

1.4 LED Light Fixtures Specifications:

1.4.1 General Purpose Led Luminaires should be suitable for indoor/outdoor installation for Office applications. The Fixtures should be Operational for 220-240 V Single Phase 50 HZ AC , and operational from 170-280 V without signidicant variation in output .The LED modules should be from approved make list Only with efficiency of a min 110 lm/watt add efficacy of fixtures should be greater than 80 lm/w for both indoor and outdoor fixtures.

1.4.2 Luminaries should be with built in Integral driver only. The Min degree of Protection for Indoor Fixtures should be IP20 and IP 44 for Semi Indoor an IP65 for Outdoor Fixtures. The THD of fixtures should be strictly <10 % and drivers should be compulsorily provided with overload, short circuit and over voltage protections. Power factor should be >0.90.

1.4.3 All fittings shall be supplied complete with lamps. All lamp fittings shall be complete with accessories like ballasts, power factor improvement capacitors, starters, etc. Outdoor type fittings shall be provided with weather proof boxes and gel connectors.

1.4.4 For Indoor applications the housing should be made of die cast/ Metal Housing and diffusers should be polycarbonate only, outdoor fixtures should be with die cast aluminum / extruded aluminum housing only .The Fixtures should be prewired up to the terminal block and easy to mount and Install and maintain.

1.4.5 All hardware used in the fitting shall be suitably plated or anodized and passivated for use in project.

1.4.6 Painting/Finish All surfaces of the fittings shall be thoroughly cleaned and degreased and the fittings shall be free from scale, rust, sharp-edges, and burrs.

1.4.7 The fixture should comply LM79-08 certification criteria and also module should be backed with LM80-08 Certificate from the OEM. The fixtures should be warranted for minimum period of 3 years from the date of Installation. The fixtures should have some kind of embossing/ engraving to identify the brand name. The manufactures should provide all kind of test report, technical details as and when called for. If required contractor have to provide test certificate from Government approved Lab for Claimed parameters by the manufacturer without any extra cost.

Technical specification of Lighting Fixtures :

S.No.	Description	Value
1	Site Parameters	
1.1	Ambient Temperature	0°C to 50°C
2	Electricity Efficiency Management/Electronic Driver	
2.1	Input Operating Voltage	110 to 270Volts, AC 50Hz±2
2.2	AC Power Factor	Not Less than 0.95
2.3	Efficiency of driver	More than 85%

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2.4	THD (AC current 110V to 250V)	Not more than 10%
2.5	LED Drive Current	Not more than 500mA
2.6	Led Efficacy	≥110lm/watt
3	Optical Management	
3.1	Colour Temperature	2700°K to 6500°K
3.2	LED life with L70 criteria	Above 50,000 operating hours
3.3	CRI	More than 70
4	Thermal Management	
4.1	Jn. Temperature of LED at 25°C	≤65°C
4.2	Heat Sink temperature rise above ambient	≤30°C
5	General parameters	
5.1	Mounting Arrangement	Mounting Angle Adjustment facility should be provided
5.2	IP Clause & Environment Protection	Minimum IP 20 for indoor, IP 44 for semi covered area and IP 65 for outdoor
5.3	Overall system efficiency	Not less than 75%

Successful Contractor has to submit test report of similar LED light fixture for following parameters from any Government Approved Test Laboratories for approval. However, test certificates of the lot to be supplied are required to be produced before supply of material at site.

For LED

- LM 80 report of the LED chip being used

For Fixtures

- Endurance Test
 - Thermal Test
 - IP rating test
 - Power factor, efficiency
 - Harmonic test
 - Surge test
 - Mechanical strength test
 - Dielectric test
 - IR test
 - Goniophotometer Reading for the LED Light
- Contractor have to give three year unconditional guarantee for replacement for each light fixture.

The electronic components used shall be as follows:-

- a) IC (Integrated circuit) shall be of industrial grade or above.
- b) Metallic film / Paper/Polyester Capacitor shall be rated for a sustained operating temperature of 105°C.
- c) The resistors should be preferably made of metal film where suitable, of adequate rating. The actual rating versus loading shall be by a factor of >2.
- d) The junction temperature of the Switching devices such as transistors and MOSFETs etc. shall not exceed 125°C (allowthermal margin of 25 °C).
- e) The protective cum adhesive coating used on PCBs should be clear and transparent and should not affect color code of electronic components or the product code of the company.
- f) The construction of PCBs and the assembly for components for PCBs should be as per relevant Indian / international standards.

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- g) The electronics covered for this equipment shall pass all the tests covered under relevant Indian / International standards specification.
- h) The infrastructure for Quality Assurance facilities must be available at the manufacturing facility. In house testing facility for Quality Assurance should be present.
- i) The connecting wires used inside the luminaries, shall be low smoke halogen free, fire retardant e-beam cable and fuse protection shall be provided in input side.
- j) For outdoor fixtures, Care shall be taken in the design that there is no water stagnation anywhere. The entire housing shall be dust and water proof having IP66 or above protection and the light shall pass driving rain test/jet water test.
- k) The LED Module(s), Driver gear, etc. shall be designed in such a way so that temperature of heat sink shall not exceed 30°C above the ambient temperature.
- l) All the material used in the luminaries shall be halogen free and fire retardant confirming to UL94.
- m) The LED Luminaries shall have an input connector which shall be made of fire retardant material & its construction shall be water proof
- n) The Contractor shall submit all the necessary support documents along with the compliance statement of all technical requirements w.r.t. Electrical, Optical, Thermal & environmental performance, including the Technical specification mentioned herewith.
- o) Each LED should have necessary lens /reflector for better distribution of light at surface.
- p) All the applicable test reports for complete fixtures and spare parts have to be submitted.
- q) The manufacturer should have in house testing facilities within the India for the fixtures intending to supply.

1.5 Ceiling Fans :

- 1.5.1 BLDC Ceiling fans shall be complete with fan suspension stem canopies and regulators. 30 cm suspension stem shall be standard accessory and stems shall be heavy duty galvanized steel tubes to IS 374- 1979.
- 1.5.2 Fans shall be mounted on a pre-embedded hook with hard rubber isolator. Regulators shall be no-step type mounted in the switch box. The box in all such cases shall be large enough to accommodate the regulator and switches. One sample box with top cover shall be got approved before procurement.



E-7 EARTHING

1.1 Scope of work

The scope of work shall cover supply, laying, installation, connecting, testing and commissioning of:

- Copper station.
- Earthing copper strips from earthing station to equi-potential bar.
- Earthing copper strips/ wires from equi-potential bar to lay feeder mains and circuit to connect power panels,
- Bonding of Non-current carrying parts, and metallic parts of the electrical installation.
- Provide inter connection between all earth pits of same type.

1.2 STANDARDS

SP:30 (BIS)	: Special Publication National Code
IS:2309	: Protection of Buildings and allied structures against lightning
IS:3043	: Code of Practice for earthing Amended up to date
IS:7689)	: Guide for control of undesirable static electricity
IEEE-80)	: IEEE Guide for Safety in AC Sub Station Grounding
IEEE-837/2014)	: Standard for Qualifying permanent connection in Sub Station Grounding
IS 1239 part1/2004)	: Steel Tubes, Tubular and Other Wrought Steel Fittings Amended up to date
IS 1239 part2/1992	: Part 2 Mild steel tubular and other wrought steel pipe fittings pipe fittings amended up to date
IS 1079/10748/2062	: Hot Rolled Carbon Steel Strip
IS 2629	: Hot Dip Galvanize
IS 4759	: Thickness of Zinc Coating
IS 1852	: Tolerance
IEC-62561 Part 1 & 2	: Lightning protection system components (LPSC) Requirements for connection components
IEC-62561 Part 7	: Lightning protection system components (LPSC) / Requirements for earthing enhancing compounds
ASTM G-57-06	: Test method for field measurement sheet for soil resistivity by using the wenner , four electrode method
IEEE STD-142 /2007	: IEEE recommended practice for Grounding of industrial and commercial power systems
IS 5216-1982	: Recommendations on safety procedures and practice in electrical work
CEA	: Measure related to safety and electric supply regulations,2010
EN-12457-2	: Characterization of Waste – Leaching – Compliance Test for Leaching of Granular Waste Materials and Sludges – Part 2
EN 12506	: Characterization of Waste – Analysis of Eluates – Determination of pH, As, Ba, Cd, Cl-, Co, Cr, Cr VI, Cu, Mo, Ni, NO2-, Pb, total S, SO42-, V and Zn.

2.0 GENERAL

All the non current carrying metal parts of the electrical installation and mechanical equipment shall be earthed properly. The metal conduits, trunking, cables armoured and sheath, electric panels boards, lighting fixtures, ceiling and exhaust fan and all other parts made of metal shall be bonded together and connected by means of specified earthing system.

An earth continuity conductor shall be installed with all the feeders and circuits and shall be connected from the earth bar of the panel boards, to the conduit system, earth stud of the switch box, lighting fixture, earth pin of the socket outlets and to any metallic wall plates used. All the enclosures of motors shall be also connected to the earthing system.

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3.0 ELECTRODE / CHEMICAL TYPE EARTHING STATIONS:

The substation earthing and equipment earthing shall be done with details given in earthing scheduled in BOQ & Drawing. The earthing station shall be as shown on the drawing. The earth resistance shall be maintained with suitable soil treatment as shown in the drawing. The resistance of each earth station should not exceed the limit specified in IS : 3043. The earthing grid and the earthing conductors shall be of copper/GI strip of size as mentioned on the drawing. The block masonry chamber with Cast Iron hinged cover shall be provided for housing the termination block as shown in the drawing. The hardware and other consumable for earthing installation shall be of copper/brass, as per details shown in the drawing.

GROUNDING: The grounding system shall incorporate the following individual components or a combination of the following:

- Deep driven copper bonded low carbon steel rod as central injection point for flow of fault current which is securely connected to the lower end of the down conductor.
- The use of ground resistance improvement material shall be applied in order to reduce the resistivity levels of the grounding system and maintain a constant low resistivity. The grounding system shall be maintenance free.

Maintenance Free Earthing System consists of following material:

- 3.1 Earth Electrode
- 3.2 Ground Resistance Lowering Compound
- 3.3 Ground Rod Clamp – For Earth Termination.

3.1 Earth Electrode

- The earth electrode is the main component of the earthing system which is meant for collecting, releasing, and discharging earth leakage and fault currents. The material should have good electrical conductivity & should not corrode in a wide range of soil conditions.
Deep driven copper bonded low carbon steel rod as central injection point for flow of fault current which is securely connected to the lower end of the down conductor.
The Copper bonded earth rods are made in accordance with national and international standards such as BS6651, BS7430 and UL467. Threads are rolled onto the rod ensuring an even copper covering which eliminates the risk of chipping whilst driving.

3.2 Ground Resistance Lowering Compound

A low resistance, non corrosive earth enhancing compound designed for use in standard soil conditions is to be used for these earthings.

This compound shall have following characteristics:

- 1 Maintains constant resistance for the life of the earthing system.
- 2 Effective in normal soil conditions.



- 3 Shall mainly consist of Carbon fiber, moisture absorbent polymers, cement and mineral moisture controller; Bentonite content shall be negligible. Shall have high conductivity, improves earth's absorbing power and humidity retention capability.
- 4 Shall be non-corrosive in nature having low water solubility but highly hygroscopic.
- 5 Shall have resistivity of less than 0.20 Ohm-m. Necessary certificate from National/ International lab for the resistivity shall also be submitted. Ground Enhancement Material must conform to IEC - 62561-7.
- 6 Shall be suitable for installation in dry form or in a slurry form.
- 7 Shall not depend on the continuous presence of water to maintain its conductivity.
- 8 Shall be permanent & maintenance free and in its —set formll, maintains its resistivity constant with time. Shall be thermally stable between -10 degree C to +60 degree C ambient temperatures.
- 9 Shall not dissolve, decompose or leach out with time.
- 10 Shall not require periodic charging treatment nor replacement and maintenance.
- 11 Shall be suitable for any kind of electrode and all kinds of soils of different resistivity.
- 12 Shall not pollute the soil or local water table and meets environmentally friendly requirements for landfill.
- 13 Shall not be explosive and shall not cause burns, irritation to eye, skin etc.
- 14 Material Should pass leaching as per EN-12457-2.
- 15 Material Should pass Sulphur as per ISO 14869-1 method.
- 16 Material Should pass corrosion as per ASTM- G-59 -97 and G-102 -89 method.
- 17 It Should be little alkaline in nature with PH value > 7 but < 9, test certificate from NABL approved to be provided for Composition so designed.
- 18 It should have capacity to retain >10% moisture at 105 degree. Test certificate form NABL approved lab to be submitted for the composition so designed.
- 19 It should have water solubility < 5%. test certificate from NABL approved to be provided for Composition. so designed.
- 20 It should be granular with granule size 0.1 to 3 mm.
- 21 It should expand & swell considerably and removes entrapped air to create strong connection between earth and soil.
- 22 It should be diffusing into soil pores and creates conductive roots enlarging conductive zone of earth pit.

Ground Resistance Improvement Powder to be used which shall not wash away under seasonal conditions and therefore provides a permanent presence in working to improve and maintain the integrity of the earthing system.

U-Bolt Rod Clamp.

Suitable for clamping earth rods to tape or round conductor.

Description:

Suitable for Rod Diam: 17MM & Suitable Size of Copper Tape as per schedule of quantities

4.0 INSTALLATION AND CONNECTION :

The electrode, as far as practicable, shall be buried below permanent moisture level but in no case not less than 2.5 M below finished ground level. The electrode shall be kept clear of the building foundation and in no case, it shall be nearer by less than 2 M from outer face of the respective building wall / column. The electrode shall be installed vertically and shall be surrounded with 150 mm. thick layers of Ground Resistance Lowering Compound . The masonry chamber shall be provided with a Cast Iron hinged cover resting over the Cast Iron frame which shall be embedded in the block masonry.

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Construction of the earthing station shall in general be as shown in the drawing and shall conform to the requirement on earth electrodes mentioned in the latest edition of Indian Standard IS : 3043, Code of Practice for Earthing Installation.

The earth conductors (Strips / Wires copper/ Hot dip G.I.) inside the building shall properly be clamped/ supported on the wall with Galvanized Iron clamps and Mild Steel Zinc Passivated screws/bolts. The conductors outside the building shall be laid at least 600 mm. below the finished ground level. The earth conductors shall either terminate on earthing socket provided on the equipment or shall be fastened to the foundation bolt and / or on frames of the equipment. The earthing connection to equipment body shall be done after removing paint and other oily substances from the body and then properly be finished. Over lapping of earth conductors during straight through in joints, where required, shall be of minimum 75mm. long. The earth conductors shall be in one length between the earthing grid and the equipment to be earthed.

5.0 EARTH LEADS AND CONNECTIONS:

Earth lead shall be bare copper or galvanized steel as specified with sizes shown on drawings. Copper lead shall have a phosphor content of not over 0.15 %. Galvanized steel buried in the ground shall be protected with bitumen and hessian wrap or polytene faced hessian and bitumen coating. At road crossing necessary Hume pipes shall be laid. Earth lead run on surface of wall or ceiling shall be fixed on saddles so that strip is at least 8 mm away from the wall surface. The complete earthing system shall be mechanically and electrically bonded to provide an independent return path to the earth source. Bimetallic Spacer / washer to be provide wherever 2 different metal (Cu. / Al. / GI) jointing with each other.

6.0 EQUIPMENT EARTHING:

All apparatus and equipment transmitting or utilizing power shall be earthed in the following manner. Copper/G.I. earth strips/wires shall be used unless otherwise indicated in the BOQ.

7.0 POWER TRANSMISSION APPARATUS

Metallic conduit shall not be accepted as an earth continuity conductor. A separate insulated / bare earth continuity conductor of size 50 % of the phase conductor subject to the minimum and maximum shall be provided. The earth continuity conductor be drawn inside the conduit shall be insulated. Nonmetallic conduit shall have an insulated earth continuity conductor of the same size as for metallic conduit. All metal junction and switch boxes shall have an inside earth stud to which the earth conductor shall be connected. The earth conduct or shall be distinctly coloured (Green or Green/Yellow) for easy identification. Armoured cable shall be earthed by two distinct earth connections to the armouring at both the ends and the size of connection being as for the metallic conduit. In the case of unarmoured cable, an earth continuity conductor shall either be run outside along with the cable or should form a separate insulated core of the cable. Three phase power panel and distribution boards shall have two distinct earth connections of the size correlated to the incoming cable size. In case of single phase DB's a single earth connection is adequate.

8.0 UTILIZING EQUIPMENT:

Three phase motors and other three phase apparatus shall have two distinct earth connections of the size equal to 50% of the connecting cable subject to the following: For single phase motors and apparatus, the single earth connection shall be provided of the above size. For all fans a single earth connection with 1.5 sqmm copper or equivalent size shall be provided. An equipment earthing grid shall be established as shown in the drawing. All earth connections to all panels, DB's and equipment shall be connected to the nearest point of the earthing grid.

Earthing shall invariably be done in the presence of the Engineer-in-Charge or his authorized representative.

9.0 TEST :

The entire earthing installation shall be tested as per requirements of Indian Standard Specification IS : 3043.

The following earth resistance values shall be measured with an approved earth meager and recorded.

- 1) Resistance of Each Earth Electrode shall be measured after disconnecting it from the grid by using standard earth test megger.
- 2) Earthing Resistance of the grid shall be measured after connecting all the earth electrode to the grid.

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3) Earth continuity conductors

Earth conductor resistance for each earthed equipment shall be measured which shall not exceed 1 Ohm in each case.

The complete Lightning Protection System measured at any point, should not exceed 10 ohms This is responsibility of contractor to get the final value for resistance. Measurements of earth resistance shall be carried out before earth connections are made between the earth and the object to be earthed. All tests shall be carried out in presence of the engineer in charge.

10.0 METHOD OF MEASUREMENT:

Provision of earthing station complete with excavation, plate, earth lead up to chamber, earth link in the chamber, electrode, GI watering pipe, Salt, Charcoal, soil treatment to achieve the earth resistance as per codes. 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/strips, clamps, labour etc.

a) Main equipment earthing grid and connection to the earthing stations.

b) At one point on earthing system used to earth electrical equipment enclosures.

c) At each electrical system earth and or system neutral system.

d) At each earth provided for structure lightning protection

e) At one point on earthing system used to earth wiring system,enclosures,such as metal conduits and cable sheath and armour..

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.

a) Conduit wiring, cabling -should form part of the wiring or cabling.



E-8 EXTERNAL LIGHTING

1.0 Scope :

1.1 The scope of work covers the supply, installation and testing of lighting poles, weather proof light fixtures, wiring to the fixtures (supply of light fixture is not included in scope), cable laying, earthing as specified and shown on drawings.

2.0 Standards :

As per Applicable standard

3.0 Light Fixtures :

3.1 The light fixture construction shall be of IP 65 die cast aluminium with a separate compartment for integral ballast equipment. The reflector shall be anodized polished aluminium. The glass refractor shall be heat-resistant.

3.2 Lamp holder shall be of porcelain and shall comprise of a terminal block of non-hygroscopic material. The luminaries shall have integral ballast housed in water tight and dust tight metal cases. Ballast shall be pre-wired to the Lamp socket and terminal block, requiring only power supply leads to the ballast p

3.3 The Lamp & fitting shall generally follow the specification under section 'LIGHT FIXTURES'.

4.0 Lighting Poles :

4.1 The lighting poles shall be fabricated from medium class GI Pipe with relevant ISI mark and zinc coated as specified. The pole shall have a base plate and necessary fixture mounting bracket at top(whenever require). Poles shall have large diameter entries for incoming and outgoing cable and two earth studs. The pole fabrication shall conform to the drawings and where such drawing is not available, the contractor shall make such drawing and have it approved before fabrication.

4.2 The pole shall house a multi-way porcelain terminal block and MCB as shown on the drawings. Pole shall have a concrete coping.

4.3 Adequate size junction box IP 65 protected suitable for outdoor mounting should be provided with pole to accommodate MCB, connectors etc.,.

4.4 Pole shall be provided with necessary brackets as per requirements Adequate size GI pipes to be provided for cable entries.

4.5 3 core round flexible wire from junction box to each light fixtures of adequate size shall be provided along with the pole.

4.6 Pole should be painted with two coats of primer and two coats of paint suitable for outdoor application of approved shade if require by architect.

5.0 Cable laying :

5.1 Cabling shall be generally as specified in the section 'CABLING'.

5.2 Cables shall be terminated in a 4-way terminal block inside the pole or attached therewith as shown on drawings.

5.3 Cable route shall be as shown on the drawings or the contractor shall mark out the route and lay the cables only upon approval of the route.

6.0 Earthing :

6.1 All street lights fixtures and poles shall be earthed as specified under section 'EARTHING'. . Each pole shall have coil type earthing with 2.4 Meter long 8 SWG GI wire.

7.0 Mode of Measurement :

7.1 Each light fitting with lamp, control gear, earthing etc. shall be considered as one unit for measurement and payment.

7.2 Each lighting pole, concrete coping, base plate earthing etc. shall be considered as one unit for measurement and payment.

7.3 All cabling work shall be measured on the basis of unit length and the cost shall include, cost of cable ,cable termination in junction boxes or pole terminal box etc.

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E-9 UPS

1.0 SCOPE:

The scope covers supply, installation, testing & commissioning of UPS system given in BOQ, complete with batteries & all accessories.

UPS:-

"True Online-Double conversion type single module UPS.

IGBT based Rectifier cum charger

IGBT based Inverter (Minimum 3 Level Inverter Switching Technology)

SMF Sealed maintenance free battery with back up time mentioned in the BOQ

Inter connecting cables; Links; Racks and standard accessories

Built in SNMPv3 card with Dry contacts & MODBUS TCP IP connectivity

AC/DC Capacitor having service life of minimum 8 Years without replacement.

UPS to battery Interconnectivity by Uninyvin type cables : Links, Racks & accessories

Contractor have to provide suitable size and numbers of copper conductor cables with termination from i from UPS to battery rack as per the manufacturer recommendations and standard engineering practice along with cable trays, hangers, clamps etc., as required. Cost of such cables,Connector0 and its related work is included in scope of UPS supply and no extra payment shall be made for the same.

2.0 GENERAL

SUMMARY

This specification describes the operation and functionality of a continuous duty, dual input feed with three-phase output power (3:3), solid-state, static Uninterruptible Power Supply (UPS) hereafter referred to as the UPS. The UPS shall utilize double conversion online topology designed to protect electronic equipment by supplying reliable, network-grade power with extremely tight voltage and frequency regulation. The UPS shall feature an internal static bypass and input power factor correction. The UPS shall be of monolithic construction as per rating given in BOQ and having internal fault tolerant architecture. Each Power module contains fully rated, Power Factor corrected Input rectifier/Boost converter, fully rated output inverter and battery charging circuit.)

Configuration Specifics:

- The system power train shall comprise of, input disconnect and filter stage, input PFC power stage, energy storage stage (DC bus capacitor bank), output power stage (inverters), static bypass switch for connecting bypass line to the output, and battery charger.
- The system shall also include, field-replaceable fan module, removable input/output wiring trays, battery disconnects, an LCD interface display, EPO, and an integrated UPS network management card with temperature monitoring.

The UPS and associated equipment shall operate in conjunction with a primary power supply and an output distribution system to provide quality uninterrupted power for mission critical, electronic equipment load.

All programming and miscellaneous components for a fully operational system as described in this specification shall be available as part of the UPS.

STANDARDS

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A. Safety:

1. IEC 62040-1: 2008-06, 1st edition Uninterruptible Power Systems (UPS) - Part 1: General and safety requirements for UPS
2. EN 62040-1: 2013-01, 1st edition amendment 1

B. EMC/EMI/RFI:

1. IEC 62040-2: 2005-10, 2nd edition Uninterruptible Power Systems (UPS) - Part 2: Electromagnetic compatibility (EMC) requirements

C. Performance:

1. IEC 62040-3: 2011-03, 2nd edition Uninterruptible Power Systems (UPS) - Part 3: Method of specifying the performance and test requirements.

D. Environmental:

1. IEC 62040-4: 2013-04, 1st edition Uninterruptible Power Systems (UPS) - Part 4: Environmental aspects – Requirements and reporting

E. Markings: CE, IEC 62040-2

MODES OF OPERATION

Normal: The input Power Factor Corrector (PFC) stage and output inverter stage shall operate in an on-line manner to continuously regulate power to the critical load. The input and output converters shall be capable of full battery recharge while simultaneously providing regulated power to the load for all line and load conditions within the range of the UPS specifications.

Design

UPS should be Insulated-gate bipolar transistor (IGBT) rectifier and with double conversion and also capable of operating in High Efficiency mode with harmonics mitigation, power factor correction and as per Class-1 classification of IEC 62040-3. Maximum 6 mili second break shall be allow transfer to Double conversion mode in case of synchronization. In High Efficiency ECO mode , THDI & power factor should be as per Input.

Operation

In online mode allows the system to supply the active part of the load through the bypass. The inverter is kept running in parallel with the bypass source and supplies the reactive part of the load. The input power factor of the UPS is, regardless of the load power factor, maintained close to unity as the reactive part of load is significantly reduced in the UPS input current. In case if an interruption to the utility/mains supply, the inverter immediately maintains the output voltage so that breaks or drops during this transfer are practically eliminated. It shall have maximum 6 mili second break for transfer to Battery mode/Double conversion Mode (VFI Mode). Efficiency shall be Minimum 96% from 25% to 100% load. In this mode UPS shall able to recharge the batteries through Inverter acting as bidirectional converter.

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The UPS shall have overall efficiency as per the relevant class of IEC 62040, however should not be less than 96%.

Battery: Upon failure of the AC input source, the critical load shall continue being supplied by the output inverters, which shall derive their power from the battery system. There shall be no interruption in power to the critical load during either transfer to or from battery operation back to normal operation.

During the re transfer from battery to on-line operation, the load shall be softly transferred from battery back on-line within 10 seconds, to avoid step load changes on the mains supply.

Recharge: Upon restoration of the AC input source, the input converters and output inverters shall simultaneously provide regulated power to the critical load and recharge the battery.

Bypass operation: Bypass mode shall be reached either as a user selection or automatically.

Bypass mode can be selected through the Control menu screen on the Power View display.

The UPS will automatically switch into bypass mode if

- Both normal and battery operation modes are unavailable
- An output overload condition occurs.
- The UPS has an internal fault.

During bypass operation the utility power is connected to the load, bypassing the internal converters. If the bypass mode becomes unavailable the UPS will automatically switch to mains power. In the event that mains power is unavailable the system will switch to battery power.

With the UPS supplied from dual feeds and operating on battery, due to a mains failure, it shall be possible to request the unit to go to bypass, in addition to automatically transfer to bypass when the batteries are depleted.

SUBMITALS.

Proposal Submittals (by successful tenderer):

- bill of materials.
- Product catalog sheets or equipment brochures.
- Product guide specifications.
- System single-line operation diagram.
- Installation information, including weights and dimensions.
- Information about terminal locations for power and control connections.
- Battery Size calculation
- GA / Shop drawings along with power and control circuit diagram

Delivery Submittals:

- Installation manual, which includes instructions for storage, handling, examination, preparation, installation, and start-up of UPS.
- User manual, which includes operating instructions.

PART-2 PRODUCT

2.1 MECHANICAL DESIGN

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The UPS shall be contained in two rugged steel cabinets one containing the power electronics and the other containing the batteries and single phase distribution outlets; UPS & battery cabinets shall be minimum IP20 rating.

The UPS shall be housed in multiple / single freestanding cabinets with dead front construction. The mechanical structure of the UPS shall be sufficiently strong and rigid to withstand handling and installation operations. The sheet metal elements in the structure shall be protected against corrosion by a suitable treatment, such as zinc electroplating or bi-chromating or epoxy paint or an approved equivalent.

PART 1 - Cable Access: UPS shall be able to Top or bottom both the type of cable entries.

The UPS shall be designed for forced air cooling. Air path should be design in such way that air can pass through all internal cabinet / accessories / PCB's

2.2 SYSTEM CHARACTERISTICS

A. System Capacity:

- a) The system shall be rated for unity PF on rated output

B. Input:

AC input nominal voltage:

- 220/230/240VAC, single phase, 3 wire (L + N + G) Up to 5 KVA
- 380/400/415VAC, three phase, 5 wire (L1+L2+L3+N+G); for above 5 KVA

AC input voltage window:

- Full Load, +/- 10% (Line-Neutral) for single phase input or +15% to -20% for three phase input;
- Half Load, +/- 10% (Line-Neutral) for single phase input or +15% to -35% for three phase input;

Input frequency range: 45 – 65 Hz

Input Power Factor; > 0.98 at 100% load

Crest factor: 3:1. At full load

Surge Factor : 1.15

C. UPS Output:

AC Output Nominal Output: (Customer configurable)

- 220VAC, 230VAC or 240VAC, Single Phase three wire, 50/60Hz; up to 5 KVA
- 380VAC, 400VAC or 415VAC, Three phase five wire, 50/60Hz; above 5 KVA

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AC output voltage distortion: Max. 2% @ 100% linear load; Max. 5% @ 100% non-linear Load;

AC output voltage regulation (Static): +/-1%;

Voltage Transient Response : +/- 8% maximum for 100% load step **Voltage Transient Recovery within**< 10ms / 20ms recovery time as per OEM standard

Output Voltage Harmonic Distortion:

- <2% THD maximum for a 100% linear load
- <5% THD maximum for a 100% non-linear load

Overload Rating:

- Online: 125% - 10 minute; 150% - 60 seconds
- In bypass:1000% for 100 msec

System AC-AC Efficiency:

- > 96 % from 25% to 100% load in double conversation
- > 98.5% from 50% to 100% load in High Efficiency Eco mode

Output Power Factor Rating: Greater than 0.9 power factor @ 40 Deg C without any derating from 0.7 lagging to 0.7 leading load power factor.

Output frequency: 50 +/- 3Hz tracking or 50 +/- 0.1Hz tracking (user selectable);

Output connectors:

- Single phase: Hardwire 3-wire (Phase + N + G),
- Three phase: Hardwire 5-wire (3 Phase + N + G)
- Output frequency Slew rate : 1.0Hz/Sec, 0.5Hz/Sec 0.25Hz/Sec

UPS should have protection against the phase reversal of incoming supply.

2.3 INPUT PFC POWER STAGE

A. The input PFC power stage of the UPS shall constantly rectify the power imported from the mains input of the system, converting the input mains AC power to DC power for precise regulation of the DC bus voltage, battery charging, and output power stage (inverter) regulated output power.

B. Input Current Total Harmonic Distortion: The input current THD_i shall be held to 6% or less at full system load, while providing conditioned power to the critical load bus, and charging the batteries under steady-state operating conditions. This shall be true while supporting loads of both a linear or non-linear type. This shall be accomplished with no additional filters, magnetic devices, or other components.

C. Input Current Limit:



The input converter shall control and limit the input current drawn from the utility supply

The input current limiter shall be designed to:

Fast battery recharge:

35% of the UPS output rating up to 80% load

12% of the UPS output rating at 80-100% load

Or as per OEM Standard

Overloads at low line input voltages shall draw power from the battery, (battery assist mode) in order to support the load and maintain the input current below the set current limit points.

Soft-Start Operation: As a standard feature, the UPS shall contain soft-start functionality, capable of limiting the input current from 0 percent to 100 percent of the nominal input over a default 10 second period, when returning to the AC utility source from battery operation. The change in current over the change in time shall take place in a linear manner throughout the entire operation

D. Charging:

The battery charging circuit shall contain a temperature monitoring / Compensation circuit, which will regulate the battery charging current to optimize battery life. The battery charging circuit shall remain active when in automatic / Static Bypass and in Normal Operation. The battery charging shall keep the DC bus float voltage within ± 1 percent of tolerance. The UPS shall be capable of reducing the battery charging current under low input voltage conditions. A potential free contact will be provided that will allow the user to inhibit Charging. The battery charging system shall adjust the charging current by automatically sensing the number of battery modules and by monitoring the individual battery current

2.4 OUTPUT POWER STAGE (INVERTER).

The UPS output power stage (inverter) shall constantly recreate the UPS output voltage waveform by converting the DC bus voltage to AC voltage through a set of IGBT switches. In both online operation and battery operation, the output power stage (inverter) shall create an output voltage waveform independent of the mains input voltage waveform. Input voltage anomalies such as brown-outs, spikes, surges, sags, and outages shall not affect the amplitude or sinusoidal nature of the recreated output voltage sine wave of the output power stage (inverter).

Overload Capability: The output power stage (inverter) shall be capable of withstanding 150% overload for 60 second or 125% overload for 10 minute. The system shall transfer to bypass if the overload persists and then return back on-line when the overload is removed.

Battery Protection: The UPS shall have monitoring and control circuits to limit the level of discharge on the battery system.

2.5 AUTOMATIC BYPASS

As part of the UPS, a system automatic bypass switch shall be provided. The system automatic bypass shall provide a transfer of the critical load from the Inverter output to the automatic bypass input source during times when the inverter cannot support the load. Such times may be due to prolonged or severe overloads, or UPS failure. The UPS shall constantly monitor the output current, as well as the bypass source voltage, and inhibit potentially unsuccessful transfers to automatic bypass from taking place.

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The design of the automatic bypass switch power path shall consist of an Static bypass switch.

Automatic Transfers: An automatic transfer of load to bypass shall take place whenever the load on the critical bus exceeds the overload rating of the UPS. Automatic transfers of the critical load from bypass back to normal. operation takes place when the overload condition is removed from the critical bus output of the system. Automatic transfers of load to bypass shall also take place if for any reason the UPS cannot support the critical bus.

Manual Transfers: Manually initiated transfers to and from bypass shall be initiated through the UPS interface display or via the serial communications port.

2.6 DISPLAY AND CONTROLS

A. Control Logic: The UPS shall be controlled by an embedded microcontroller which performs the following functions:

1. Monitoring quality of input, bypass and output voltages;
2. Monitoring vital parameters of the UPS;
3. Executing the state machine.
4. Intelligent battery management.
5. Remaining runtime calculation.
6. Self-diagnostics, self-test and proactive fault detection.
7. Communication to the host server via serial port.
8. Communication to the Network Interface Card or another Smart Slot accessory card if equipped.

B. Display Unit: A microprocessor controlled display unit shall be located at the front of the system. The display shall consist of an alphanumeric display with backlight, providing system status, LED alarm indicators and a keypad consisting of pushbutton switches for control and status reading selection.

C. Metered Data: The following metered data, shall be available on the alphanumeric display:

1. Year, Month, Day, Hour, Minute, Second of occurring events
2. Source and Bypass Input Voltages
3. Output AC voltage
4. Input, Bypass and Output AC currents
5. Input, Bypass and Output Frequency
6. Battery voltages and currents
7. Internal and battery pack temperature

D. Event log: The display unit shall allow the user to display a time and date stamped log of the 100 most recent status and alarm events.

E. Alarms: The display unit shall allow the user to display a log of all active alarms. The following minimum set of alarm conditions shall be available:

1. Input Frequency outside configured range
2. AC adequate for UPS but not for Bypass
3. Low/No AC input, startup on battery

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4. UPS Fault
5. On Battery
6. Shutdown or unable to transfer to battery due to overload
7. Load Shutdown from Bypass. Input Frequency Volts outside limits
8. Fault, Internal Temp exceeded system normal limits
9. System level fan failed
10. Runtime is below alarm threshold
11. Load is above alarm threshold

12. Load is no longer above alarm Threshold
13. Minimum Runtime restored
14. Bypass is not in range (either frequency or voltage)
15. UPS in Bypass due to Internal Fault
16. UPS in Bypass due to overload
17. Low Battery Shutdown
18. Low Battery Warning

F. Controls: The following controls or programming functions shall be accomplished by use of the display unit. Pushbutton switches shall facilitate these operations.

1. Silence audible Alarm
2. Display or set the date and time
3. Transfer critical load to and from bypass
4. Test battery condition on demand
5. Set intervals for automatic battery tests
6. Adjust set points for different alarms

G. Communication Interface Board: Regular recording of parameters in 10 milli seconds interval to be recorded preceding a fault event. These events to be stored in memory and can be exported in user friendly formats. A communication interface shall provide the following communication ports which can be used simultaneously:

1. RJ-45 Interface port for Power View Display
2. RJ-45 Ethernet connection, on installed Network Management Card
3. MODBUS TCP/IP Port
4. Dry Contacts Card
5. RS 232 serial port

2.7 BATTERY

A. External SMF Battery

1. The UPS battery system shall comprise of user replaceable external batteries providing required voltage DC nominal for the positive DC bus rail and required voltage DC nominal for the negative DC bus rail. as per manufacturer standard. Details to be submitted.
2. The battery blocks shall be of the Valve Regulated Lead Acid (VRLA) type.

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3. The UPS shall incorporate an Intelligent Battery Management system at battery bank level to continuously monitor the health of the battery system and notify the user if that system is weak or needs replacing.

B. General description for Batteries

Batteries shall be of the Sealed Lead-Acid type.

4. Each battery system shall have identical Amp-hrs capacity.
5. Ground wires shall be supplied for connection from the UPS to each battery enclosure grounding point.

C. Charging:

1. Charging system shall automatically adjust the maximum charger power, based on the installed proprietary battery capacity and current through each battery string to avoid excessive charging that could result in bloated batteries. Each proprietary battery pack shall report its battery currents and temperature to UPS through communication.
2. The intelligent battery management system shall contain a temperature monitoring circuit and compensation algorithm that regulates the battery charging current so as to optimize battery life. The UPS shall monitor the temperature of all proprietary battery packs and use the highest one as a reference to adjust the battery float voltage.
3. The battery charging circuit shall remain active when in bypass or on-line.
4. Overall battery monitoring is required individual cell monitoring is not required.

Part-3 ACCESSORIES

3.1 INPUT/OUTPUT ELECTRICAL TERMINAL

The input and output terminal connections shall be designed to be for easy electrical connection.

3.2 SOFTWARE AND CONNECTIVITY

A. Network Adaptor: Built in Smart Slot Network Management Card shall allow one or more network management systems (NMS) to monitor and manage the UPS in TCP/IP network environments.

B. Unattended Shutdown

1. The UPS, in conjunction with a network interface card, shall be capable of gracefully shutting down one or more operating systems when the UPS is operating in the battery mode. Network Shutdown software shall be available with the UPS.
2. The UPS shall also be capable of using an RS232/RS485 port to communicate with the host computer by means of serial communications so as to gracefully shut down one or more operating systems during an on battery situation.

3.3 REMOTE UPS MONITORING, CONFIGURATION AND CONTROL

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The following three methods of remote UPS control, configuration, and monitoring to be provided.

Web Monitoring: Remote monitoring shall be available via a web browser such as Internet Explorer.

RS232/RS485 Monitoring: Remote UPS monitoring shall be possible via either RS232/RS485 or contact closure signals from the UPS.

Simple Network Management Protocol V3 (SNMPv3): Remote UPS Monitoring shall be possible through a standard MIB II compliant platform.

3.4 SOFTWARE COMPATIBILITY

The UPS manufacturer shall have available software to support graceful shutdown and remote monitoring for the systems detailed

Part - 4 EXECUTION

4.1 START-UP

Start-up is requested, factory trained service personnel shall perform the following inspections, test procedures, and on-site training:

A. Visual Inspection:

1. Inspect equipment for signs of damage.
2. Verify installation per manufacturer's instructions.
3. Inspect cabinets for foreign objects.
4. Inspect battery chassis and modules.
5. Inspect power chassis

B. Mechanical Inspection

1. Check all UPS and internal power wiring connections.
2. Check all UPS and nuts, and/or spade lugs for tightness.

C. Electrical Inspection:

1. Verify correct input and bypass voltage.
2. Verify correct UPS control wiring and terminations.
3. Verify voltage of all battery modules.
4. Verify neutral and ground conductors are properly landed.
5. Inspect external service bypass panel for proper terminations.

D. Site Testing:

1. Ensure proper system start-up.
2. Verify proper control functions.
3. Verify proper bypass operation.
4. Verify system set points.

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5. Verify proper inverter operation and regulation circuits.
6. Simulate utility power failure.
7. Verify proper charger operation.
8. Document, sign, and date all test results.

E. On-Site Operational Training: During the factory assisted start-up, operational training for site personnel shall include key pad operation, LED indicators, start-up and shutdown procedures, maintenance bypass and AC disconnect operation, and alarm information.

4.2 MANUFACTURER FIELD SERVICE

Worldwide service: The UPS manufacturer shall have a worldwide service organization available, consisting of factory trained field service personnel to perform start-up, preventative maintenance, and service of the UPS system and power equipment. The service organization shall offer 24 hours a day, 7 days a week, 365 days a year service support.

Replacement parts: Parts shall be available through the worldwide service organization 24 hours a day, 7 days a week, 365 days a year. The worldwide service organization shall be capable of shipping parts within 4 working hours or on the next available flight, so that the parts may be shipped to the customer site within 24 hours.

4.3 MAINTENANCE CONTRACTS

A complete offering of preventative and full service maintenance contracts for the UPS system and the battery system shall be available from the vendor. All contract work shall be performed by the vendor's factory trained service personnel.

4.4 TRAINING

UPS service training workshop: A UPS service training workshop shall be available from manufacturer. The service training workshop shall include a combination of lecture and practical instruction with hands-on laboratory sessions. The service training workshop shall include instruction about safety procedures, UPS operational theory, sub-assembly identification and operation, system controls and adjustment, preventative maintenance, and troubleshooting.



Following rates shall be considered as basic rates for arriving at the tender rates by the bidder.

SR NO.	TYPE OF LIGHT FIXTURE	BASIC RATE	PRICE RANGE
1	Internal Light Fixtures Type A	Rs. 1500/-per Meter	Any
2	Internal Light Fixtures Type B	Rs. 2000/-per No.	Up to Rs. 3000
3	Internal Light Fixtures Type C	Rs. 4500/-per No.	Above Rs. 3000 & Up to Rs. 6000
4	Internal Light Fixtures Type D	Rs. 10000/-per No.	Above Rs. 6000
5	External Light Fixtures Type E	Rs. 21000/-per No.	Any

The above basic rates are inclusive of all types of taxes, levies, loading, transit insurance, transportation, unloading and delivery at site.

Contractor shall inform and get approval of the employer in writing about the purchase rates and source of supply of the items listed under basic rate before placing the order. Material shall be purchased directly from manufacturer or their authorized main stockiest / supplier. The contractor shall get approval of such rates from engineer in charge at least minimum one month in advance of placing the order of the relevant material. Employer reserves the right to negotiate and finalize the rates of the items listed under basic rate items directly with the supplier / authorized dealer.

The approved rates shall be termed as negotiated rates (inclusive of all types of taxes, levies, loading, transit insurance, transportation, unloading and delivery at site) and the same shall be binding to the contractor for further process of execution. Contractor shall execute the relevant item considering the negotiated rates as final rate. The contractor shall prepare and submit the statement of basic rate difference for all relevant items (Performa of the statement is given below) with each running bills and final bill. The supporting documents like approved rate quotation, delivered quantities, invoice received from supplier, payment details etc. as required by engineer in charge shall be attached with this statement for Employer's verification and record. The amount of basic rate difference shall be claimed in every running bill. Final adjustment can be made during final bill after proper reconciliation of total executed quantities and material supplied quantities.

No other component of cost as stated in the Performa below shall be considered for payment or recovery of material listed under basic rate item. Refer table below for deriving amount of basic rate difference payable or recoverable.

Electrical contractor should quote considering only Installation, Testing & Commissioning charges in addition of basic rate for Supply.

Sample Calculations is as under.

Sr. No	Item	Unit	Basic Rate as per tender (a)	Negotiated rates (b)	Quoted Rate (c) (assumed)	Rate Difference (d) = b-a	% difference with basic rate (e) = d / a	Deducti on in QR f= c x e	Final payable amount g=c+f
Example									
1	Internal	No	4500	3375	5625	-1125	- 25.0%	-1460	4165
2	Internal	No	4500	5625	7000	1125	+ 25 %	NA	8125 (c+ d)

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SPECIAL CONDITION FOR TESTING
(CONTRACTOR TO READ THIS CAREFULLY)

1.0 SCOPE :

Contractor should take all necessary testing/ random testing of equipments and component prior to supply as per the guidelines / rules / sampling method etc. of IS at manufacturing works or other standard lab in presence of Client's representative & consultant as witness testing. Any deviation in parameters which is not as per IS is not accepted and client reserve the rights to reject the same at any stage of the project.

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List of Approved Makes (Electrical)		
Sr No.	Material / Item	Approved Make
1	XLPE insulated sheathed AL/CU conductor armored / unarmored 1.1KV grade power cable.	Finolex, Polycab, KEI, Havells, Gloster, Avocab, Torrent
2	LT Fire survival Cables	Finolex, Polycab, KEI, Havells, Gloster, Avocab, Torrent
3	Control Cable(ISI Approved)	Finolex, Polycab, KEI, Havells, Gloster, Avocab, Torrent
4	Cable Gland	Comet , Dowell's, Jainson, HMI, Raychem, Baliga, Skytone ,3-D
5	Cable Lugs	Comet , Dowell's, Jainson, HMI, Raychem, Baliga, Skytone ,3-D
6	LT Power Distribution Panels (Other than TTA)	Siemens, Schneider, ABB, L&T , Legrand, C & S, ELDON (CPRI Approved)
7	MCB/RCCB / SPD/RCBO /and all other accessories	Legrand-,Schneider-, Hager , LK – E & A ,ABB
8	MCCB	Schneider , Siemens, LK – E & A, Legrand ABB,C &S, Havells
9	On Load Change over switch / Switch Fuse Units	L&T, Siemens, ABB, Schneider,
10	AC Power Contactor, DC Power Contactor, Auxiliary contactors	Siemens, L&T, Schneider, Legrand,ABB,EPCOS,CGL
11	Panel Accessories, Selector Switches (ASS/VSS), Auxiliary Relays, Rotary Switch , Push Buttons, Indicating Lamps	As per OEM standard.
12	Timers	Schneider, Siemens, L&T, ABB ,Theben,Legrand, Hager, finder,C &S
13	Current Transformer (Cast Resin Epoxy Coated)	Automatic Electric, Gilbert & Maxwell, Kappa, Ashmor
14	Terminal Block / Cage Clamp / Connectors	Wago, Elmex,Connectwell, pheonix
15	Multifunction and digital electronic meter with LED Display.	Schneider (Conserve), Legrand, LK- E & A, Siemens, ABB, Neptune, Secure , Rishabh
16	Single phase preventer	Siemens ,Schneider, ABB , LK- E & A
17	HRC Fuse and Fuse Fitting	ABB, GE, Siemens, L&T, Schneider
18	Surge Protection Devices	Legrand, Schneider, Hager, LK- E & A, OBO
19	Distribution Boards (MCB DBs) and cable end loosing box	Legrand, Schneider, Hager, LK- E & A, ABB
20	Sandwich and air insulated Type Bus Duct/Rising mains(indoor)	Schneider, Legrand, LK- E & A ,C&S
21	Copper Conductor FRLSH Insulated Wires/ Stranded Flexible Wires	Finolex, RR Kabel, Havells, Polycab, Lapp India, KEI , Ravin cable [FRLSH type], Avocab
22	Television Cable	Finolex, RR Kabel, Havells, Polycab, Lapp India, KEI, Ravin cable, Avocab
23	MS Black Stove Enameled ERW Conduits(ISI Approved) and its accessories	AKG, BEC, Steelkraft, Rm con
24	PVC Conduit & Accessories(ISI Approved)	Precision ,BEC, AKG, Astral, Nihir
25	Ceiling Fan	Crompton, Usha , Orient, Bajaj, Havells
26	Fan Box	For Conceal : Cast Iron/ GI continously welded/ PVC same as pipe make. [with rod and hook assembly]
		For Open : Anchor Fastner with hook as per approved make listed separately.

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27	Anchor Fasteners	Hilti , 3M , Fischer, Wurth
28	Modular Switches with accessories, Socket Outlets And Wiring Accessories With Moulded Cover Plate.	Schneider(Unica Pure)/ Legrand(Arteor)/ MK Honeywell (Blenz Plus)/ LK- E & A (Englaze)/ Havells(Murano)/ ABB(Ivie)
29	Industrial PVC Plug &Socket - Indoor	Legrand, Schneider, LK- E & A, Siemens,hensel, Neptune, BCH
30	Plug & Socket (Outdoor) - IP 54 and above	Hensel, Splesberg, OBO, Legrand, Schneider, Neptune Bals
31	Thermoplastic Boxes	Hensel, Splesberg, OBO, Legrand, Schneider
32	Batton Holder, Angle Holder Ceiling Rose	Anchor , CPL, Havells, Legrand
33	PVC Tape	Anchor, Steelgrip, Nippon , Finolex , BCH
34	Wire mesh Cable Trays and its supports and accessories	OBO, Legrand, Indiana (Vadodara), Profab (PUK)
35	Cable Trays and its supports and accessories (Other than wire mesh)	Indiana (Vadodara) ,OBO, Profab (PUK), MEM, Pilco, Super steel industries, Anant power
36	Cable Management System (Wire Trunking) Raceway [under floor and surface]	OBO, Legrand , MK (Honeywell), profab (PUK)
37	Sensor (Occupancy Sensor/ Day Light etc)	Honeywell, Hager, Philips, Theben, Legrand, Finder, Lutron, Crestron, Schneider, ABB, Panasonic
38	Fire Stopper / Cable coating / sealant	Hilti , 3M , OBO, Wurth, Fischer,
39	Lightning Protection System as per IEC-62305	Dehn, OBO, ABB, Cape electric
40	Insulation Mat	Tata, Jyoti, Premier, deepjyoti
41	Chemical Earthing	Dehn, OBO, ABB, Cape electric,
42	Light Fixture	Philips,Wipro,K lite,Jaquar,Havells,Regent ,Alurays, Lighting Technology, Keselec,Reiz,Hybec, Endo, Ledlinear, Pluslight tech, Regent, XAL, Osram, Trilux, Crompton,Tucana & Neri
43	LED	Cree, Nichia, Osram, Philips
44	DWC pipe and accessories	Rex, Duraline, Gemini, Supreme , Reliance ,Astral, Tirupati, Ciphon
45	UPS	Emerson(vertiv), Schneider (APC),Numeric (Legrand), Eaton



Special Notes :

- The successful tenderer will have to supply the makes from above in consultation with the Client/Architect/Consultant without any extra cost.
- The successful tenderer will have to do follow up for getting approval from supply company for individual user meter connection final certificate / Approval from authorities. Filling the necessary application to supply co. following up and getting the supply filling the necessary test report to the supply Company without any extra cost.
- As far as possible, the successful tenderer will have to place order directly to the manufacturer OR it's authorized dealer.
- The Client/Architect/Consultants have right to check the challans of supplier.
- The MCB and MCB DBs must be of same make.
- Make of components reired to be used by contractor to complet the installation, if not mentioned any where, shall be required to GOT IT APPROVED by Client/Architect/Consultant before installation in writing manner.
- Within a week of work order, the contractor shall submit the sample of each item / component of above mentioned approved make for the approval of the Client/Architect/Consultant.

Sign & Seal of Contractor

Bidder Signature

**APPLICABLE STANDARDS**

Sr. No.	IS No.		Description
1)	IS: 13118-1991	:	Specification for AC circuit breakers.
2)	IS: 2705-1992	:	CT for measuring and protection.
3)	IS: 3155-1992	:	Voltage (Potential) Transformers.
4)	IS: 3155-1992	:	Voltage Transformer.
5)	IS:8623 -Part II 1993	:	Bus-bar arrangement and marking.
6)	IS: 3842-1967	:	Relays.
7)	IS: 1248-2003	:	Meters (measuring).
8)	IS: 10118-1982	:	Installation of Switch gears.
9)	IS: 3043-1987	:	Code of practice for earthing.
10)	IS:13947-Part III -1993	:	HD Air breaker, Switch gears and fuses voltage not exceeding 1000 Volts.
11)	IS:13703-Part IV -1993	:	Selection, installation and maintenance of fuses up to 650 Volts.
12)	IS:13947-Part I -1993	:	General requirements for switch gear and control gear for voltage not exceeding 1000 Volts.
13)	IS: 13947-Part III -1993	:	Air-break isolators for Voltage not exceeding 1000 Volts.
14)	IS:8623-1993	:	Factory built assemblies of switch gears and control gears for voltage up to and including 1000 Volts A.C. and 1200 Volts D.C.
15)	IS:11353-1985	:	Marking and arrangement of switch gear bus bars main connectors and auxiliary wiring.
16)	IS: 2147-1962	:	Cubical Boards.
17)	IS: 8084-1976	:	Insulated conductor rating.

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- 18) IS: 2675-1983 : Enclosed distribution fuse boards and cutouts for Voltage not exceeding 1000 Volts.
- 19) IS: 8828-1995 : Miniature Circuit Breaker.
- 20) IS: 9926-1981 : Fuse wire used in rewirable type electric fuses up to 650 Volts.
- 21) IS: 1554-Part I
-1998 : PVC insulated electric cables Heavy duty.
- 22) IS: 3961-Part II
1967 : Recommended current rating for cables.
- 23) IS: 8130-1984 : Copper conductor in insulated cables and cores.
- 24) IS: 8130-1984 : Conductor for insulated electric cables and flexible cords.
- 25) IS: 3975-1999 : Mild steel wires, strips and tapes for armoring cables.
- 26) IS: 5831-1984 : PVC insulation and sheath of electric cables.
- 27) IS: 8130-1984 : Aluminum conductor for insulated cables.
- 28) IS: 11955-1987 : Recommended current rating for Cable.
- 29) IS: 732-1989 : Code of practice for electrical wiring installation system Voltage not exceeding 650 Volts.
- 30) IS: 1646-1997 : Code of practice for fire safety of Buildings (general) electrical installation.
- 31) IS: 9537-1981 : Rigid steel conduits for electrical wiring.
- 32) IS: 2667-1988 : Fittings for rigid steel conduits for electrical wiring.
- 33) IS: 3480-1966 : Flexible steel conduit for electrical wiring.
- 34) IS: 3837-1976 : Accessories for rigid steel conduits for electrical wiring.
- 35) IS: 694-1990 : PVC insulated cables (wires).
- 36) IS: 9537-Part III
-1983 : Rigid non-metallic conduits for electrical wiring.



- 37) IS: 6946-1973 : Flexible (playable) nonmetallic conduits for electrical installation.
- 38) IS: 1293-2005 : Three pin plugs and sockets.
- 39) IS: 8130-1984 : Conductors for insulated electrical cables and flexible codes.
- 40) IS: 9537-1980 : Specification for conduit for electrical installation.
- 41) IS: 3419-1988 : Accessories for non-metallic conduits for electrical wiring.
- 42) IS: 3854-1997 : Switches.
- 43) IS: 6538-1971 : Plugs.
- 44) IS: 13925-Part I : Shunt Capacitors for power systems.
-1998
- 45) IS: 9385-1979 : HRC cartridge fuse and links up to 660 volts.
- 46) IS: 1913-1978 : General and safety requirement for lighting fittings.
- 47) IS: 1944-1981 : Code of practice for lighting public thorough fares.
- 48) IS: 3528-1966 : Waterproof electric lighting fittings.
- 49) IS: 3553-1966 : Water tight electric lighting fitting.
- 50) IS: 1239-Part I : Mild Steel tubular and other
-2004 wrought steel pipe fitting.
- 51) IS: 10322-Part V : Luminaries for street light.
-1987
- 52) IS: 93703-Part III : HRC fuses having rupturing
-1993 capacity of 90 KA.
- 53) IS: 2312-1967 : Exhaust Fan.
- 54) IS: 374-1979 : Class I Ceiling Fan.
- 55) IS: 7098 (Part I, II, III) : XLPE armoured Cables.
-1985&86



56) IS:7098 (Part I&II) : XLPE armoured Cables.

NOTE : All codes and standards means the latest where not specified otherwise the installation shall generally follow the Indian Standard codes of practice or relevant British Standard Codes of Practice in the absence of corresponding Indian Standards.

ALSO FOLLOW :

- a. Indian Electricity Act and rules issued there under revised up to date.



TECHNICAL SPECIFICATIONS (HVAC WORKS)

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1.0 DIRECT EXPANSION TYPE SPLIT AIR CONDITIONING SYSTEM

1.1 BROAD SPECIFICATIONS

The scope of this section comprises the Supply, installation; testing and commissioning of Air-cooled Split Units as per the Ratings & Quantities provided under the Bill of Quantities.

The Split Unit Package shall comprise of Indoor and Outdoor units and shall be as per the ratings shown in the BOQ.

The ceiling suspended type duct able units shall be comprising of an Indoor type Fan-Coil unit (installed within the room) and Outdoor Air-Cooled Condensing unit connected through insulated refrigerant piping. The system shall be charged with first charge of refrigerant after proper pre-commissioning process.

Indoor (fan coil) unit shall be ceiling suspended type comprising of DX coil with finned copper tubes (Evaporator), Low noise design Fan unit with motor & belt drive package; fan unit shall have proper insulated and leak proof condensate base connected to drain piping with suitable trap and laid up to nearest drain point designed to ensure zero leakage; the fan assembly shall be dynamically balance for low vibration and low noise type design.

The outdoor (condensing unit) shall be of Corrosion resistant Galvanized powder coated or equivalent paint Sheet steel low vibration assembly installed on suitable vibration isolators and comprising of energy efficient scroll / rotary compressor with controls such as thermal protector, HP / LP cut outs, Pressure relief valve; the outdoor unit shall also comprise of finned tube air cooled condenser and condenser fan unit; the units shall have integral refrigerant copper piping within compressor and condenser and accessories such as refrigerant shutoff valves at compressor / compressors and liquid refrigerant outlet if required & filter dryer; Cooling fans shall have protective metal frame.

1.1.1 EVAPORATOR UNIT

The Microprocessor based Unit shall be complete with Factory supplied Microprocessor based Control Panel, Power and Control wiring & earthing.

i. EVAPORATOR

The Indoor unit is of sectionalized construction of corrosion resistant heavy gauge steel, finished with enamel paint and consisting of fan section, coil and filter section, and insulated drain pan.

ii. COOLING COILS

DX Cooling coils shall be 3 Row Coil - fin and tube type having aluminium fins firmly bonded to copper tubes assembled in G.I. Frame. Face surface area of cooling coils should be adequate for the air quantity handled and air velocity across the coil shall not exceed as recommended for the application. Aluminium fins shall be corrugated and collared with mechanical bonding. The coil shall be three rows (or as required) deep and fin spacing is 5 fins/cm.

iii. EVAPORATOR FAN

Fan impellers and housing shall be fabricated with heavy gauge steel. Fan impeller shall be forward curved, multi blade type enclosed in housing and mounted on a common shaft. All rotating parts shall be statically & dynamically balanced. Vendor shall be checking the condition of Fan at site accordingly prior to start up and commissioning.

iv. EVAPORATOR MOTOR

Fan motor shall be squirrel cage totally enclosed fan cooled type of adequate capacity suitable to operate on three phases, 400/440 volts, 50 cycles AC supply. Fan motor shall be mounted on an adjustable vibration-isolating base located on the casing of the unit. Fan shall be driven directly or through standard v - belts with belt guard. The belt drive package shall be adequately designed to meet the desired design CFM.

v. FILTER

Each filter shall be HDP washable or metallic type with adequate thickness. Filter holding frame shall be designed such that leakage of air can be avoided. Velocity across filter shall not exceed design requirement.

1.1.2 AIR COOLED CONDENSING UNIT

(i) Casing

Condenser casing shall be made of corrosion resistant heavy gauge steel finished with enamel paint. If specified it shall be epoxy painted or powder coated.



- (ii) Compressor
Compressor shall be energy saving scroll / rotary type Compressor (Twin or Single as per Unit rating) & shall be complete with required accessories such as pipe flanges, suction strainers, muffler, suction and discharge pressure gauges, oil heaters, oil pressure gauge, HP - LP cut out, OP cut out, pressure relief valve, overload for motor protection etc. Compressor shall be suitable to operate on 3 phase, 400/440 volts, 50cycles AC supply and shall be designed to withstand voltage fluctuation of 15 %.
- (iii) Condenser coil
Condenser coil shall be of copper tubes having aluminium fins firmly bonded to tubes. Tube dia. shall be between 12.5 to 15 mm.; min. 24 g wall thickness and fin spacing shall be 5 fins per cm. Condenser coil shall be three rows deep. Each coil shall be factory tested at 21 kg./sq.cm. test pressure.
- The coil shall have integral sub-cooling circuit. The air volume and coil face area shall be adequate for the capacity. Air velocity across the coil shall not exceed design requirements. Air volume of the condenser shall be minimum 25 Cu. Mt. / Min. per ton of refrigeration capacity. If specified, the coil shall be made out of tinned copper tubes and tinned copper fins.
- (iv) Condenser Cooling Fans
Fans shall be propeller axial type. One or more fans shall be provided for the required capacity.
- (v) Condenser Cooling Fan Motor
Fan motor shall be TEFC, squirrel cage, induction motor suitable to operate on 3 phase, 50 cycles, 400/440 volts, 50 cycles, AC supply and provided with pulley, v belt set or direct drive flexible coupling with guards. Motor shall have class "B" insulation and shall be provided with weather protection.
- (vi) Connections with valves
(i) Refrigerant gas inlet connection, Liquid refrigerant outlet connection.
(ii) Pressure relief valve drain valve and air-vent valve.
- (vii) Installation
Entire air-cooled condensing unit assembly shall be installed on MS channel stand through vibration isolators and at the place as indicated in drawings. If specified spring isolator and Hot dip galvanized / epoxy painted structure shall be provided. Entire Evaporator assembly shall be supported through MS rods of required mm and suspended from the slab and at the place as indicated in drawings.
- (viii) Painting
All equipments including base frame etc. shall be factory painted with two coats of a suitable enamel paint of approved colour over a rust resistant primer. Paint that have become marred during shipment or erection shall be cleaned off with mineral spirit, wire brushed, and spot primed over the affected areas, then coated with enamel paint to match the colour shade of original painted surface.
- (ix) Testing
All safety controls like HP cut out, LP cut out, line flow switches/differential pressure switches shall be checked for their functioning and setting and record of all the settings shall be submitted to consultant/client. The procedure for testing and commissioning shall be as approved by the consultants. The contractor shall provide all testing and measuring instruments.

1.1.3 MICROPROCESSOR BASED CONTROL PANEL

The microprocessor-based control panel shall be with digital display showing trip and status conditions; it shall have a membrane/alternate design user-friendly key board for set-point control. It shall as a minimum provide following features:

- i. Auto-switch off of the condenser fan when the compressor cuts off for power saving.
- ii. Single button starts and stop flexibility for the user; the sequences for start and stop shall be take care by the controller.
- iii. Integrated electronic temperature sensor for precise measurement and consequent control of return air temperature.
- iv. Compressor starts up delay timer for compressor protection & increase operational life.
- v. Auto restart on power restoration – optional.

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1.1.4 Package Unit Starter Panels

The Panels shall be supplied by HVAC Vendor only and factory constructed and preferably wall mounted type, 2mm CRCA, totally enclosed, completely dust and vermin proof and degree of protection being not less than IP: 54 to IS: 2147. Gaskets between all adjacent units and beneath all covers shall be provided to render the joints dust proof. All doors and covers shall be fully gasketed with foam rubber and /or rubber strips and shall be lockable. The painting shall be seven tank processes with epoxy paint.

Each circuit breaker and switch fuse unit shall be housed in separate compartments and shall be enclosed on all sides. Sheet steel hinged lockable door shall be duly interlocked with the breaker / switch fuse unit in 'ON' and 'OFF' position.

The Panels shall be equipped complete short-circuit & overload safeties as minimum with required number of MCB / MCCBs, Starters, switch fuse units, contactors, relays, fuses, Voltmeter & Ammeters, Phase indicating lamps, push buttons, equipment, fittings, cable boxes, cable glands etc. & all the necessary internal connections / wiring as required.

All related interlocks for safe operation (ON / OFF) of compressor shall be built into the hardwired/digital relay logic in the starter panel.

A. HIWALL SPLIT UNITS

Hi-Wall Mount Split Units shall be remote control operated and shall be with single or multi splits design as per the ratings and quantities provided in the schedule of quantities.

The units shall be ready-to-operate type and shall comprise of an Indoor type Fan-Coil unit (installed within the room) and Outdoor Air-Cooled Condensing unit connected through insulated refrigerant piping. The system shall be charged with first charge of refrigerant after proper pre-commissioning process.

Single phase connection shall be provided by user at one point near each Hi Wall split unit. Rest of the electrical work including cabling from the power point up to the Unit's electrical panel including voltage stabilizer shall be supplied, laid & installed by vendor only.

The units shall be of one among the Approved Makes mentioned elsewhere in this Contract.

A1 Brief Features desired in Indoor (Fan-Coil) Unit

- Hi Gloss, finish all fibre body
- Highly efficient 3 layered air purification system to remove dust/bacteria and odours from the return air.
- Four bend heat exchanger design for efficient heat transfer
- Noise level of Indoor Unit at operating speed shall not be exceeding 48 dB measured at a distance of 3 M from source.
- Operated through remote control having a large LCD display, temperature set-point, sleep mode operation, On/Off timer, Real time clock, Auto-restart, filter status warning, dry mode operation (reduces the humidity without the temperature when required)

A2 Brief Features desired in Outdoor Condensing Unit

- Operating on single phase 230±10% V supply
- Preferred Rotary / Scroll compressor design for low power consumption per ton generated – not exceeding above 1.28 kW per TR
- Electrolytic zinc steel sheet with antirust coated components to ensure rust free outdoor unit even in humid condition.
- Hydrophilic fins to improve the heating efficiency by accelerating the defrosting process

2.0 NOISE AND VIBRATION CONTROL

General

This section of the Specification intends to direct the Contractor to select the appropriate and sufficient noise and vibration control measures on the plant/equipment, the interconnected piping, ductwork and conduit so that when the installed plant/equipment are put into operation, the resulting noise and vibration levels at locations within the building and at the adjacent or nearby buildings shall not exceed the acceptable limits.

The Corrected Noise Level at potential Noise Sensitive Receiver in the adjacent or nearby building, if so identified in

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the Particular Specification and/or Drawings, shall not exceed the Acceptable Noise Level stipulated in the Technical Memorandum for the Assessment of Noise from Places other than Domestic Premises, Public Places or Construction Sites issued by the Environmental Protection Department when the plant/equipment installed by the Contractor are put into operation.

Equipment Bases

General

Floor mounted equipment shall be installed on 100 mm high concrete housekeeping pads provided by the Building Contractor covering the whole floor area requirements of the equipment bases plus a minimum of 150 mm further on each side or on inverted beams at the roof. Vibration isolators shall be mounted on this concrete pad or inverted beams.

Welded Structural Steel Bases

Bases shall be constructed of adequate T or channel steel members reinforced as required to prevent the bases from flexing at start-up and from misalignment of drive and driven units. All perimeter members shall be of steel sections with a minimum depth equal to 1/10th of the longest dimension of the base but need not exceed 350 mm provided that the deflection and misalignment are kept within acceptable limits as determined by the equipment manufacturer. Height saving brackets shall be employed in all mounting locations to provide a base clearance of 50 mm.

Concrete Inertia Bases

Concrete inertia bases shall be formed within a structural steel beam or channel frame reinforced as required to prevent flexing, misalignment of the drive and driven units or transferable of stresses into equipment. The base shall be completed with height saving brackets, concrete reinforcement and equipment bolting down provisions.

In general the thickness of concrete inertia bases shall be of a minimum of 1/12th of the longest dimension of the base but never be less than 150 mm. The base depth needs not exceed 300 mm unless specifically required.

As an indication of the standards required, minimum thickness of the inertia base shall generally comply with the following table or be 1/12th of the longest dimension of the base, whichever is the larger:

Motor Size (KW)	Minimum Thickness
3.7-11	150mm
15-37	200mm
45-55	250mm
75 -185	300mm

Base forms shall include minimum concrete reinforcement consisting of 13 mm bars or angles welded in place on 150 mm centers running both ways in a layer of 40 mm above the bottom, or additional steel as is required by the structural conditions.

Unless otherwise specified, concrete inertia bases shall weigh from 2 to 3 times the combined weight of the equipment/plant to be installed thereon.

Base forms shall be furnished with drilled steel members and with anchor-bolt sleeves welded below the holes where the anchor bolts fall in concrete locations.

Height saving brackets shall be provided in all mounting locations to maintain a base clearance of 50 mm.

Vibration Isolators

The following types of vibration isolation mountings or suspensions are not exhaustive but serve to cover the main types that shall be applied as appropriate unless otherwise stated in the Particular Specifications.

Free Standing Spring Mounts

These shall be free standing and laterally stable without any housing and complete with a minimum of 6.0 mm neoprene acoustical friction pads between the base plate and the support.

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All mountings shall have leveling bolts that must be rigidly bolted to the equipment.

Spring diameters shall be no less than 80% of the compressed height of the spring at rated load with horizontal spring stiffness 1.1 times the rated vertical spring stiffness. Springs shall have a minimum additional travel to 'solid' (fully compressed) equal to 50% of the rated deflection.

Springs shall be so designed that the ends of the springs remain parallel.

The springs selected for any given application shall be non-resonant with the equipment's or support structure's natural frequencies. This shall apply to all springs hereafter described.

Restrained Spring Mounts

Equipment with operating weight different from the installed weight such as chillers, boilers etc. and equipment exposed to the wind such as cooling towers and other roof mounted plants shall be mounted on spring mountings but a housing shall be used that includes vertical limit stops to prevent spring extension when some of the weight is removed, i.e. when the system is drained or lifted by abnormal wind pressure.

Double Deflection Neoprene Mounts

These mountings shall have a minimum static deflection of 8.5 mm. All metal surfaces shall be neoprene covered to avoid corrosion and shall have friction pads on both the top and the bottom so that they need not be bolted to the floor. Bolt holes shall be provided for applications where bolting down is required.

Neoprene Pads

These mountings shall consist of 'waffle' form neoprene pads of 8.0 mm thickness. Where required these shall be adhesive cemented to 3 mm steel plate of similar area so as to form a sandwich.

The area of pad to be used and the number of layers shall be determined for each application in accordance with the manufacturer's recommendations.

3.0 INSULATION

Scope

The scope of this section comprises the supply and application of insulation conforming to these specifications.

Damaged insulation on Existing installed services (Duct & Piping) should be also considered to improve overall efficiency of the system.

3.1 Drain pipe insulation.

(Class 'O' Nitrile - 9 mm thick sleeve without bonded cloth & neither self sleeve Nitrile shall be used for drain piping) i.e. Only plain Nitrile rubber sleeve to be applied with the help of specified adhesive :

Material technical specifications:

- Insulation material shall be Closed Cell Elastomeric Nitrile Rubber
- Thermal conductivity of elastomeric Nitrile rubber shall not exceed 0.035 W/(m.K) at an average temperature of 0 °C
- The insulation shall have fire performance such that it passes Class 1 as per BS476 Part 7 for surface spread of flame as per BS 476 and also pass Fire Propagation requirement as per BS476 Part 6 to meet the Class 'O' Fire category as per 1991 Building Regulations (England & Wales) and the Building Standards (Scotland) Regulations 1990
- Material shall be FM (Factory Mutual), USA approved.
- Moisture Diffusion Resistance Factor or 'μ' value shall be minimum 7,000.

Adhesive - It should be as per recommended by insulation manufacturer. It should be Modified chloroprene rubber adhesive in a blend of solvents, free from benzene. The adhesive shall be of low viscosity for ease of application

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and quick drying characteristics. The properly cured adhesive shall maintain water vapour resistance expected of insulation. It should have service temperature same as of insulation.
The adhesive shall be quick drying characteristics for tropical conditions and shall have service temperature of - 40 to + 105 degree °C.
Specifications: 13 mm thick Nitrile sleeve for drain piping insulation. It shall be plain sleeve without bonded & without self sleeve.

3.2 Shaft insulation :

Insulation Materials Technical Specifications - Resin Bonded foam with one Side Company Bonded Aluminum foil.
Material: Resin Bonded foam
Density: 80 Kg/M³
Insulation Thickness: 50 mm
Facing: Aluminum foil faced (FSK)

- Thermal Conductivity of Resin Bonded slab foam shall be 0.038 W/m.K at an average mean temperature of 35 deg °C
- It shall have R Value of 7.45hr*ft²*F/BTU (Thermal Resistance Value)
- Temperature Range: up to +750 deg °C
- The insulation material (Resin Bonded slab) shall have A Fire Performance Grade
- Resin Bonded Rockwool Slabs are manufactured for Thermal and acoustical application
- Size: 1000 mm x 500 mm
- Confirming Standards: IS 8183 and ASTM C612
- The insulation material should be Incombustible and moisture resistant & also it should not cause or accelerate any type of corrosions

Application Procedure:

Providing & Fixing Resin Bonded Insulation slabs having density of 80 Kg/m³ and thickness of 50 mm covered with company bonded Aluminum foil with the help of screw & washer – Cross wire system.

3.3 Refrigerant Piping Insulation

Scope

The scope of this section comprises the supply and application of insulation conforming to these specifications.
Insulation for Refrigerant piping

A. Inside the Building

Supply Side: 13 / 19 MM Nitrile Sleeve Without Bonded & Without Self Sleeve. (For 6mm ID (1/4") thickness shall be 13 mm, rest all the ID's up to 48mm id (1 7/8") thickness shall be 19 mm)

Return Side: 13 MM Nitrile Sleeve without Bonded & without Self Sleeve (For all the ID's from 6mm (1/4") to 48mm id (1 7/8").

Material Technical Specifications:

- Insulation material shall be Closed Cell Elastomeric Nitrile Rubber
- Thermal conductivity of elastomeric Nitrile rubber shall not exceed 0.035 W/ (M.K) at an average temperature of 0°C
- The insulation shall have fire performance such that it passes Class 1 as per BS476 Part 7 for surface spread of flame as per BS 476 and also pass Fire Propagation requirement as per BS476 Part 6 to meet the Class 'O' Fire category as per 1991 Building Regulations (England & Wales) and the Building Standards (Scotland) Regulations 1990

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- Material shall be FM (Factory Mutual), USA approved.
- Moisture Diffusion Resistance Factor or 'μ' value shall be minimum 7,000.

(ADHESIVE)

It should be supplied by insulation manufacturer. It should be Modified chloroprene rubber adhesive in a blend of solvents, free from benzene. The adhesive shall be of low viscosity for ease of application and quick drying characteristics. The properly cured adhesive shall maintain water vapour resistance expected of insulation. It should have service temperature same as of insulation.

The adhesive shall be quick drying characteristics for tropical conditions and shall have service temperature of - 40 to + 105 degree °C.

B. Outside the Building or Open to sky & wherever mechanical protection is needed following procedure to be followed.

- Additional covering of treated woven glass fibre over Nitrile sleeve for mechanical & U.V. protection

4.0 PAINTING - COLOUR CODE.

All **Equipments** shall be supplied with approved finish. Shop coat 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 two coat of synthetic enamel paint. Pump base-plate / piping supports subject to water exposure to be painted with rubber paint using zinc base primer. Water treatment Units to be painted with anticorrosive paint / CGC, as exposed to acid and caustic solutions.

All **sheet steel work** shall undergo a process of degreasing, thorough cleaning, and painting with a high corrosion resistant primer. All panels shall then be baked in an oven. The finishing treatment shall be by application of synthetic enamel paint of approved shade.

All exposed condenser water piping shall be applied with cold galvanizing spray / paint.

4.1 Standard Colour Code:

The tentative colour code given below shall be followed. However changes if any will be indicated well in advance. All painting colour code shall be approved before execution. No separate payment shall be made for painting work.

ITEM :	COLOUR:
<ul style="list-style-type: none"> ▪ Motors ▪ AHU ▪ All supports / Stands / drain ▪ Ducting / Grilles / Diffusers 	<ul style="list-style-type: none"> ▪ Siemens Grey ▪ Mulshell Grey ▪ Dark Blue ▪ Black ▪ Approved by Architect

All "Approved shade" shall be duly approved by Engineer In-charge / Architect.

5.0 INSPECTION AND TESTING

5.1 Inspection (pre-dispatch & site), testing & acceptance

Pre-dispatch inspection shall be carried out for certain items. All the system equipments, parts shall be checked for physical damage, before commencing the installation work. Complete fabrication, installation and commissioning work shall be jointly supervised and shall be carried out as per the specifications and instructions of site Engineer In-charge. All the rotating equipment shall be checked for static and dynamic balancing, minimum operating vibration and noise.

All the system / equipments shall be checked before / after satisfactory commissioning, at manufacturer's works / site as may be required for the approved technical specifications, performance data provided by supplier / manufacturer. Actual capacity of each equipment shall be calculated based on the test readings, recorded jointly for design conditions / operating conditions. Performance acceptance is subject to comparison of test results with supplier / manufacturer's performance data and contract specification. Acceptance is subject to satisfactory installation, commissioning and performance testing with respect to technical specifications. Rejected items must be replaced or rectified for the defects. In case of system modification / rectification complete performance tests are to be repeated. Site test readings shall be jointly recorded.

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5.2 Methodology

In general following Inspection / tests are involved. Type of test, duration of test, testing procedure / parameters, will be as per the applicable BIS codes. However the detail Inspection and test procedure shall be worked out jointly by the purchaser and the contractor along with the approval of drawings, within 30 days from the date of contact agreement.

- a. Pre-dispatch Inspection (as per client/consultant's format)
- b. Pre-dispatch testing at manufacturers shop / factory. (Material, performance, pressure, joints, etc.)
- c. Physical Inspection – Pre-installation at site.
- d. Brazing / welding joint inspection and testing at site.
- e. Pressure and / or leak testing at site.
- f. Performance testing at site (capacity, power consumption, pressure drop, vibration, etc.)
- g. Calibration at site if required

SR. NO.	ITEM / EQUIPMENT	INSPECTION / TEST INVOLVED.
1.	AC Units	a, b, c, e, f.
2.	Refrigerant Piping	c, d, e
3.	Inline / Propeller Fans	a, b, c, e, f
4.	Ducting	c, e
5.	Insulation	c
6.	Diffusers / Dampers and Grilles	c

5.3 Test certificates and documents

Contractor shall furnish following Test certificates for Approval / Information of Client / Consultant.

Material Test Certificates for items 1, 2, 3, 4, 5 under table mentioned above.

Welder's / Brazer's qualification certificate.

Performance test certificates and Calibration Certificates - carried out by manufacturer before Pre- dispatch inspection & testing.

All equipment operation and maintenance manual.

5.4 TESTING THE EQUIPMENTS AT SITE

The following aspects shall be considered for performance testing.

- Prevailing conditions shall be as close as to design conditions at the time of performance testing procedure.
- Type, quantity, location, frequency, duration of test parameters shall be decided and recorded accordingly during the test.
- Rated capacity, power consumption, and other operating parameters shall be checked.
- Functional test for all Instruments, controls (safety and capacity) shall be carried out to check for the expected operation / action / accuracy / response time / repeatability parameters.

(a) Air Conditioning Unit:

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The unit shall be selected and installed for the lowest operating speed and noise level. Capacity ratings and power consumption with operating points clearly indicated shall be submitted and verified at the time of testing and commissioning of the installation. Measurements of air flow rate and temperature of air entering the DX coil (Return Air) and leaving the coil (Dew Point Temperature) shall be used to ascertain tonnage capacity of each unit. Calibration certificates of the measuring instruments shall be furnished by vendor.

Power consumption shall be computed from measurements of incoming voltage & input current.

Above Air side and Electrical Side measurements shall be carried out simultaneously for arriving at the measured performance at site.

(b) Control & Instruments:

All Instruments shall be factory calibrated and provided with necessary instructions for site calibration and testing. Various items of the same type shall be completely interchangeable and the manufacturer shall guarantee their accuracy. All automatic controls and instruments used in the DX unit (Thermostat / Pressure Cut-outs) shall be tested at site for accuracy and reliability before commissioning the installation.

(c) Piping:

- Refrigerant Piping Test Procedure shall be submitted for approval by the short listed bidder for approval of Client / Consultant
- All piping shall be tested to hydrostatic test pressure of at least one and half times the Maximum operating pressure, but not less than 10 kg/cm² gauge for a period of not less than 24 hours. All leaks and defects in joints revealed during the testing shall be rectified and gotten approved at site.
- Piping repaired subsequent to the above pressure test shall be re-tested in the same manner.
- System may be tested in sections and such sections shall be securely capped, then re-tested for entire system if called for.
- The Contractor shall give sufficient notice to all other agencies at site of his intention to test a section or sections of piping and all testing shall be witnessed and recorded by Owner's site representative.
- The Contractor shall make sure that proper noiseless circulation of fluid is achieved through all coils and other heat exchange equipment in the system concerned. If proper circulation is not achieved due to air bound connection, the Contractor shall rectify the defective connections. He shall bear all expenses for carrying out the above rectifications including the tearing up and re- finishing of floors and walls as required.
- The Contractor shall provide all materials, tools, equipment, instruments, and services and labour required to perform the test and to remove water resulting from cleaning and after testing.

(A) Inspection Check List

SR. INSPECTION ITEM NO.	SYSTEM COMPONENTS	
	DUCTABLE / HI WALL / HIDE AWAY UNITS	AIR DISTRIBUTION
1. Physical	- Body	- Sheet metal Work / Ducting
2. Fabrication, Installation & commissioning	- Compressor - Condenser - Cooling Coil	- Dampers - Diffusers / Registers / Grilles

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3. Vibration and noise.	- Fan- Blower - TSE valve. -Refrigerant piping	----- - Supports etc.
4. Insulation and painting.	- Accessories	

(B) Testing:

All the system / equipments shall be checked after satisfactory commissioning, for the tender specifications, performance/ technical data provided by supplier / manufacturer. Actual capacity all equipments shall be calculated based on the test readings, recorded jointly, for design conditions / operating conditions. Performance acceptance is subject to comparison of test results with supplier / manufacturer's performance data and contract specification. In case of system modification / rectification complete performance tests are to be repeated. Following test readings shall be jointly recorded.

(C) Test Reading sheet:

Duct able / Hi Wall Split / Hide Away / Cassette type Air conditioning Units.

(i) Unit:

Main volts / Amps.

(ii) Compressor:

Refrigerant suction pressure (LP, Bar) / Temp. °C.
 Refrigerant Discharge pressure (HP, Bar) / Temp. °C
 Discharge cutout pressure (Bar)
 Discharge cut in pressure (Bar)
 Suction cutout pressure (Bar)
 Suction cut in pressure (Bar)
 Compressor motor Amp.

(iii) Cooling Coil:

Surface (Face) area - Sq. Mt.
 Return (entering coil) air Temp. DBT / WBT °C
 Supply (leaving coil) air Temp. DBT / WBT °C
 Air velocity across the cooling coil – Mt. / Min.
 Air volume -CMH capacity

(iv) Air cooled Condenser:

Air Temp. In - DBT °C
 Air velocity across the coil - Mt. / Min.
 Air Temp. at Fan outlet - DBT °C
 Air Temp. at Grilles, Supply Duct outlets - DBT °C
 Air volume - CMH at Supply Duct outlets
 Air volume – CMH at fresh air intake

(v) Room Conditions:

Average reading of DBT / WBT °C, at 12-00 PM, 14-00 PM, and 16-00 PM on a test (summer / monsoon) day, shall be recorded to check the inside / room design condition.

6.0 COMMISSIONING PROCEDURE

Commissioning shall be done before handover of system.

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A Performance Quality (PQ) measurement document shall be issued by Vendor for consultant's review to follow the Commissioning procedure.

Balancing of Air flow across all diffusers for single AHU such that the total CFM meets the design CFM delivered by AHU

Ensuring Inside conditions at peak load committed in designs.

7.0 IS CODES

Following IS CODES will be applicable for the project.

- 1) IS: 659 - 1964 : Safety Code for Air-conditioning.
- 2) IS: 660 - 1963 : Safety Code for Mechanical Ref.
- 3) IS: 5111 - 1969 : Code of Practice and Measurement Procedure for Testing Refrigerant Compressors.
- 4) IS: 325 - 1970 : Specifications for 3 Ph. Induction Motor. Also confirm to IS: 1231 for Foot Mounted & IS: 2223 for flange mounted motors.
- 5) IS: 2147 - 1962 : Degree of protection provided by enclosures for low Voltage switches and control gears.
- 6) IS: 3012 - 1965 : Code of Practice for installation (PART-I) & Maintenance of switchgear.
- 7) IS: 3016 - 1982 : Code of Practice for Fire precautions in welding and cutting operations.
- 8) IS: 3615 - 1967 : Glossary of terms used in Refrigeration & Air conditioning.
- 9) IS STD. FOR INSULATION WORK-**
 - 9.1) IS: 4671 - 1984 : Expanded Polystyrene for Thermal insulation purposes
 - 9.2) IS: 661 - 1974 : Code of Practice for Thermal Insulation of Cold Storage.
 - 9.3) IS: 7240 - 1981 : Code of Practice for Application and finishing of Thermal Insulation
 - 9.4) IS: 7413 - 1981 : Code of Practice for Application material at Temp. from – 80°C to 40 °C & finishing of Thermal Insulation material at Temp. from 40 °C to 700 °C.
 - 9.5) IS: 8183 - 1976 : Specifications for Bonded Mineral Wool.
- 10) IS: 1239 : Pipes up to 150 MM Dia.
- 11) IS: 3589 : Pipes above 200 MM Dia.
- 12) IS: 780/ISI : Values of PN 1.6 rating Certificate
- 13) IS: 5312/ISI : Check Valves Certificate
- 14) IS: 900 : Installation of motor
- 15) IS: 4064 & 4047 : Switch fuse unit
- 16) IS: 2516 : ACB
- 17) IS: 3069 : Glossary of Items symbols & units relating to thermal materials.
- 18) IS: 702 : Industrial bitumen.
- 19) IS: 8183 : Bonded Mineral Wool
- 20) IS: 655 – 1963 : Ducting work.

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- 21) IS: 277 : For Sheet galvanizing spec.
- 22) IS: 3043 -1963 : Earthing.
- 23) IS: 3043 : Earth Station.
- 24) IS: 732 – 1963 : Testing of Electrical Installation.
- 25) IS: 520 : Standard for positive displacement Refrigeration, Compressor and condensing unit.
- 26) IS: 2825 : Unfired pressure vessels.
- 27) IS: 4503 : Shell and Tube type Heat Exchanger.

8.0 TECHNICAL DATASHEET

(List of Technical Information to be furnished by the Bidder)

- **Equipments:**
- **Technical details :**

Note:

- ✓ Separate Technical data sheet shall be furnished for different type / model / configuration for any item.
- ✓ All data sheets shall be endorsed with stamp and signature by bidder.
- ✓ Contractor has to provide minimum technical details as enclosed herewith, however shall also provide remaining / additional details for approval. All the Items shall be ordered only after Technical specification approval.
- ✓ Attach Technical leaflets, performance curves, etc. for all products / system parts offered.

9.0 INFORMATION TO BE FURNISHED BY THE TENDERER ALONG WITH THE TENDER TECHNICAL DATA SHEETS:

A) DOCUMENT : TECHNICAL DATA SHEET FOR HI SIDE EQUIPMENTS

Conventional DX System - DATA SHEET										
A	Compressor	Data by Bidder								
	TR		1.0		1.5		2.0		2.5	
1	Type									
2	Make / Model									
3	Quantity									
4	KW (Motor Connected)									
5	KW (Motor Consumed)									
6	Full Load Current									
7	Refrigerant Capacity – At 5 °C Suction & 43 °C discharge									
8	Refrigerant									
B	Condenser									

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1	Type																			
2	Air Quantity																			
3	Coil Face Area																			
4	No. of Rows																			
5	By pass Factor																			
6	Fan Motor KW / RPM																			
7	Full load Current of Fan Motor																			
8	Static Pressure of Fan																			
9	No. of speed for Fan																			
10	Copper Tube thickness / Diameter																			
11	Aluminum fins spacing / Gauge																			
C	Evaporator																			
1	Type																			
2	Air Quantity																			
3	Coil Face Area																			
4	No. of Rows																			
5	By pass Factor																			
6	Fan Motor KW / RPM																			
7	Full load Current of Fan Motor																			
8	Static Pressure of Fan																			
9	No. of speed for Fan																			
10	Copper Tube thickness / Diameter																			
11	Aluminum fins spacing / Gauge																			
D	Overall Dimensional details																			
1	Condensing Unit																			
2	Evaporating Unit																			
E	Salient Features																			
1	Type of filter																			
2	Filter area																			
3	Filtration level																			
4	Any other details																			
F	Total power consumption of the unit																			
1	For all condensing units at full capacity																			
2	For all indoor units at full capacity																			
G	Tolerances																			
1	Voltage																			

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2	Power Factor											
3	Frequency											
Vendor Seal												
Signature												
Date												

B) DOCUMENT : TECHNICAL DATA SHEET FOR INSULATION

SR. NO.	SPECIFICATION	DESCRIPTION
1.	Expanded polystyrene ' TF ' quality/ Fibre Glass / Cross Linked Polyethylene	
2.	Make / Thickness /Density / Thermal conductivity / coating / covering/ finish etc For : Refrigerant Pipe Insulation Duct Insulation Duct Acoustic Lining Room Acoustic Lining Under deck Insulation	

Note:

- a. Technical brochures of following items to be enclosed with the bid
- Air Conditioning Units for capacities offered
 - Ventilation Fans
 - Insulation Materials
- a. Actual makes considered in the bid shall be strictly indicated

10.0 TECHNICAL DEVIATION STATEMENT

SR. NO.	Original Tender Condition	Deviation
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Volume 2

LIST OF APPROVED MAKES

5.1 List of Approved Makes

- Contractor shall use the material of approved make as indicated below unless specified otherwise in BOQ or as approved by the Employer's representative.
- The Contractor shall ensure the correct selection of the approved make meeting the specifications and application duties. Before placing order for procurement, the sample of approved make shall be got verified for its suitability to the specification and application duty. However, Employer's representative/engineer reserves the right to opt for best preferred listed make.
- The Contractor shall quote the rate for material and equipment as per the list of approved makes. In the event of the Contractor wants to use alternate makes other than those stipulated for any reason, the Contractor can send a proposal after ensuring that what he proposes at the least meets both the quality, and safety standard of the stipulated makes, and the financial benefit that will accrue to the Employer. He shall also stand full guarantee to his alternate proposal. The alternate makes can be used only after an approval accorded by the employer, whose decision will be final in the matter.

SR. NO.	DESCRIPTION	MANUFACTURERS
1	Air cooled DX	Daikin / Toshiba / Mitsubishi Electric / LG / Samsung / Mitsubishi Heavy / General
2	Anchor / Fastener	Hilti / Fisher / MUPRO
3	Steel Wire Rope Support / duct supporting arrangement	Gripple / Conklin / HILTI / Mupro
4	UPVC Pipes	Finolex / Prince / Supreme / Ashirwad / Astral.
5	Flexible Duct	Twiga / RuskinTitus / Kimmco / Sevenstar / Supreme
6	Flexible Pipe Connection	Cori / Flexitronics / Resistoflex
7	PVC Pipes	Finolex / Prince / Supreme / Ashirwad / Astral
8	Refrigerant Piping	Mandev / Mexflow / Hariom
9	Insulation	
9.1	Fibre glass insulation	Owens corning / U. P. Twiga
9.2	Closed Cell Nitrile rubber insulation/ EPDM insulation	Armaceil / K- Flex / A-Flex / ALP aeroflex / supreme
9.3	Protective Coating over Closed Cell Nitrile Rubber	Armaceil / K- Flex / A-Flex / ALP aeroflex / supreme
9.4	Acoustic Insulation	Armaceil / K- Flex / A-Flex / ALP aeroflex / supreme
9.5	'TF' quality Expanded polystyrene	Beardsell / Styrene / Cooline
9.6	PUF Pipe Supports	Malanpur / Lloyd / Beardsell
10	Fire Wrap / Board / Fire Paint	Birla 3 M / Hilti / Promat Flamebar / AMEETUFF / 3M / promat / JAY & CO-Cischem
11	Air Filters / Hepa Filters	American Air Filter / Camfil / Thermodyne / Freudenberg / Airtech
12	HVAC Controls	Belimo / Carrier / Danfoss / Honeywell / Johnson Controls / Siemens / Trane
13	Cables	
13.1	Power Cables	As per Electrical Section make list
13.2	Control Cables	
13.3	Electrical Cable Glands	As per Electrical Section make list
14	ON / Off Push Buttons	As per Electrical Section make list
15	Single Phase Preventer	As per Electrical Section make list
16	Thermal Relay	As per Electrical Section make list
17	Indicating Lamps	As per Electrical Section make list
18	Lugs	As per Electrical Section make list
19	Relays / Push Buttons	As per Electrical Section make list
20	Current Transformer	As per Electrical Section make list

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21	Digital Meters	As per Electrical Section make list
22	Timer / Limit Switch	As per Electrical Section make list
23	MV Modular Panels	As per Electrical Section make list
24	Steel Wire Cable Trays	As per Electrical Section make list
25	Chemical Earthing	As per Electrical Section make list
26	Paint	Asian / Berger / ICI / Nerolac

Note:

- Equipments not appearing above shall be preapproved for makes before procurement.
- Data sheets for all BOQ equipments supplied shall be preapproved before procurement
- All ISI marked items shall be supplied with type test certificates suitable to the ratings marked for the application.
- All approved makes shall be supplied with serial nos. cross referred with OEM approved test certificates.
- All equivalent makes shall be prior approved before dispatch to site by client.
- Mockup / sample to be approved by architect / client for all material especially the ones visible externally.
- Shade and Finish of the Diffusers, Grilles & SS Perforated sheet to be approved by Architect before supply by Contractor to site; samples to be submitted for approval of Architect

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