

CHAPTER – A**TECHNICAL SPECIFICATIONS
FOR CIVIL WORKS****1 GENERAL**

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

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

1.3 Before commencement of any item of work the Contractor shall correlate all the relevant Architectural and Structural Drawings, and Specifications etc. and satisfy himself that the information available is complete and unambiguous. The Contractor alone shall be responsible for any loss or damage occurring by the commencement of work based on any erroneous and or incomplete information and no claim whatsoever shall be entertained on this account.

1.4 The Contractor (s) should engage approved, licensed plumbers for the work. The Contractor(s) shall submit for the approval of the Engineer-in-Charge, the name of the plumbing Contractor proposed to be engaged by him.

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

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

1.7 Sample of building materials, fittings and other articles required for execution of work shall be got approved from the Engineer-in-Charge before use in the work. The quality of samples brought by the Contractor shall be judged by standards laid down in the relevant CPWD/ BIS specifications. All materials and articles brought by the Contractor to the site for use shall conform to the samples approved by the Engineer-in-Charge which shall be preserved till the completion of the work.

1.8 BIS marked materials except otherwise specified shall be subjected to quality test at the discretion of the Engineer-in-Charge besides testing of other materials as per the specifications described for the item/material. Wherever BIS marked materials are brought to the site of work, the Contractor shall, if required, by the Engineer-in-Charge, furnish manufacturer's test certificate or test certificate from approved testing laboratory to establish that the material / procured by the Contractor for incorporation in the work satisfies the provisions of specifications / BIS codes relevant to the material and or the work done.

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

1.10 Contractor shall submit “Quality Assurance” plan.

1.11 The Contractor shall ensure that no construction leachate (e.g. cement slurry etc.), is allowed to percolate into the ground. Adequate precautions are to be taken to safeguard against this including, reduction of wasteful curing processes, collection, basic filtering and reuse. The Contractor shall follow requisite measures for collecting drainage water run-off from construction areas and material storage sites and diverting water flow away from such polluted areas.

2. CHECK-LIST FOR EXECUTION OF WORK

i) As and when any important item is taken up for execution, the Contractor shall submit the specifications and develop a checklist and Pour card. This sample checklist should be got approved from the Engineer-in-charge and

should be used at site. This check list should be shown to the Engineer-in-charge or his authorized representative during inspection. This procedure is to be followed for all hidden items, CC/RCC work, Steel-reinforcement, shuttering, Doors & Windows, Plumbing, including Water supply pipe lines, Roof treatment, Earth filling etc.

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

3 EARTH WORK:

3.1 Site Clearance

Before the earth work is started, the area coming under cutting and filling shall be cleared of shrubs, rank vegetation, grass, brushwood, trees and saplings etc. and rubbish removed/disposed off by the contractor at his own cost to the place as directed by Engineer-in-charge.

3.2 Earth Work

i) Earth work, by mechanical and manual means in Excavation for Foundation, Roads, Footpaths, Drains and Trenches etc. in all kind of soil/strata/ordinary rock/ hard rock as per terrains and drawings. In case of very hard rock where excavation using machinery is not possible or taking lot of time, hydraulic splitters or chemical can be used for rock fragmentation for which nothing extra shall be paid.

ii) For all excavation operations executed manually or by mechanical means, irrespective of the stipulations in the relevant CPWD Specifications or elsewhere in the Contract the excavated earth shall be put to use in the areas related to the work and thereafter the extra earth shall be used in filling up the low-lying areas of the total plot, at his own cost. If there is any surplus excavated earth thereafter, the same shall be disposed off by the contractor at his own cost to the place as directed by Engineer-in-charge and no payment will be made by the Authority for disposal of this excavated earth.

iii) Filling in foundation with available excavated moorum/earth (excluding rock) in trenches, plinth, sides of foundations, roads, drains and footpaths etc. in layers not exceeding 20 cm in depth, consolidating each deposited layer by ramming and watering. Additional earth, if required for the filling, for the work shall be dug from nearby areas. Only earth shall be used for plinth filling. Filling in plinth shall be in layers and consolidated with water and compacted with pneumatic rammers, to achieve 90% relative density on testing. One test is to be carried out for 1000 sqm. of compacted area or as specified in CPWD specifications.

iv) Any other excavation or filling required at open areas other than building like landscaping, horticultural works, road works etc. for completion of work as per approved drawings shall be in the scope of work.

v) Black cotton soil (if present) shall be removed at all places where permanent structure will be constructed.

vi) The Contractor shall make, at his own cost, all necessary arrangements for maintaining water level low enough in the area where works are under execution, so as not to cause any harm to the works or problems in carrying out with the execution and the rates for all items of work shall be considered as inclusive of pumping out or bailing out water, if required, for which no extra payment shall be made. This will include water coming from any source, such as rains, accumulated rain water, floods, leakages from sewer and water mains subsoil water table being high or due to any other cause whatsoever. The Contractor shall make necessary provision of pumping, dredging, and bailing out water coming from all the above sources and excavation and other works shall be kept free of water by providing suitable system approved by the Engineer-in-charge.

vii) Any other type of earthwork not specifically mentioned herein up to the completion of project shall be in the scope of work.

3.3 Anti-termite treatment:

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

4 PLAIN CEMENT CONCRETE (PCC) AND REINFORCED CEMENT CONCRETE WORK(RCC):

4.1 Stone Aggregate:

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

4.2 Sand

Sand to be used for the work shall be of as specified in CPWD Specifications 2019. Sand shall be obtained from the source to be got approved by the Engineer-in-charge and washed if required, with appropriate equipment to bring down the chemical, inorganic and organic impurities within the permissible limits as per the direction of the Engineer in charge. The same shall consist of hard siliceous materials.

Note:

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

4.3 Cement

i) The contractor shall procure 43/53 grade Ordinary Portland cement conforming to IS 8112 /Portland Pozzolana Cement conforming to IS 1489 (Part I) as required in the work, from manufacturers as per list of approved makes or from any other reputed cement manufacturer having a production capacity not less than one million tons per annum, in case the cement is not available from manufacturers as per list of approved makes. The bidders may also submit a list of names of cement manufacturers which they propose to use in the work. The bid accepting authority reserves right to accept or reject name(s) of cement manufacturer(s) which the bidder proposes to use in the work.

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

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

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

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

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

4.4 Fly-ash

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

4.5 Centering, Shuttering and Scaffolding:

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

4.6 Reinforcement:

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

ii) Nothing extra will be paid for "straightening of bars" received from market in coils or with bends. All incidental charges of any kind whatsoever including cartage, storage, safe custody of materials, cutting and wastage etc. shall be borne by the contractor.

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

iv) For checking nominal mass, tensile strength, bend test & re-bend test etc. specimen of sufficient length shall be cut from each size of the bar.

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

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

4.7 Concrete Work

All concrete work will be done by automatic computerized batching plant of suitable capacity installed at site or RMC as per approval of Engineer-in-Charge.

4.8 Transportation, Placing and Compaction of Concrete

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

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

iii) In case concrete is to be transported by pumping, the conduit shall be primed by pumping a batch of mortar / thick cement slurry through the line to lubricate it. Once the pumping is started, it shall not be interrupted (if at all possible) as concrete standing idle in the line is liable to cause a plug. The operator shall ensure that some concrete is always there in the pump-receiving hopper during operation. The lines shall always be maintained clean and shall be free of dents.

iv) Materials for pumped concrete shall be batched consistently and uniformly. Maximum size of aggregate shall not exceed one-third of the internal diameter of the pipe. Grading of aggregate shall be continuous and shall have sufficient ultra-fine materials (materials finer than 0.25mm). Proportion of fine aggregates passing through 0.25mm shall be between 15 & 30% and that passing through 0.125 mm sieve shall not be less than 5% of the total volume of aggregate. When pumping long distances and through hot weather, set- retarding admixtures may be used. Admixtures to improve workability can be added. Suitability of concrete shall be through pumping shall be verified by trial mixes and by performing pumping tests.

4.9 Plain Cement Concrete (PCC)/ Lean Concrete

i) Lean Concrete of required thickness under foundation, plinth, footpath, ramp, and any other place as required of M-10 grade (design mix) shall be provided and laid in position ready mixed or site batched design mix cement concrete using coarse aggregate and fine aggregate derived from natural sources, Portland Pozzolana/Ordinary Portland/Portland Slag cement, admixtures in recommended proportions as per IS: 9103 to accelerate / retard setting of concrete, to improve durability and workability without impairing strength; including pumping of concrete to site of laying, curing, carriage for all leads.

ii) Lean Concrete of M-10 grade or as specified Grade (design mix) as specified above shall be executed on ground and above all floor below flooring to accommodate ducts/ Raceways etc. required for laying LAN cables, wires etc. with thickness of PCC as per actual requirement to accommodate all ducts, wiring, LAN cables, Raceways etc.

iii) In case of small quantity, 1:3:6 (1 Cement: 3 coarse sand (zone-III): 6 graded stone aggregate 20/40 mm nominal size derived from natural sources) or 1:4:8 (1 Cement: 4 coarse sand (zone-III): 8 graded stone aggregate 40 mm nominal size derived from natural sources) as per CPWD specifications may be done with prior approval of Engineer-in-Charge.

4.10 RCC Work (Concrete Mix Design)

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

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

iii) The Engineer-in-Charge reserves the right to exercise control over the:

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

b) Calibration check of the plant.

c) Weight and quantity check on the ingredients, water and admixtures added for batch mixing.

d) Time of mixing of concrete.

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

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

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

4.11 Concrete Batching Plant (Design Mix)

i) Contractor can install concrete Batching Plant of suitable capacity within period of 30 days from award of work or can use ready mix concrete (RMC). The contractor shall install batching plants (preferably within the site or 50 meters distance from the site of work) supplying Concrete at site. The batching plant proposed to be engaged by the contractor shall fulfil the following requirements.

a) It shall be fully computerized.

b) Facility to pump concrete up to the highest point of the building.

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

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

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

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

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

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

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

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

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

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

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

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

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

xiii) Proportioning Concrete

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

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

Measurement of Cement $\pm 2\%$ of the quantity of cement in each batch

Measurement of Water $\pm 3\%$ of the quantity of water in each batch

Measurement of Aggregate $\pm 3\%$ of the quantity of aggregate in each batch

Measurement of Admixture $\pm 3\%$ of the quantity of admixture in each batch

xv) Mixing Concrete

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

4.12 Ready Mix Concrete (RMC)

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

a) It shall be fully computerised.

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

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

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

iii. The contractor shall, within 30 days of award of the work submit list of at least three reputed RMC plant companies along with details of such plants Including details of transit mixer, pumps etc. to be deployed indicating

name of Company, its location, capacity, technical establishment, past experience for approval by Engineer-in-charge.

iv. The Engineer-in-Charge reserves the right to exercise check over the:

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

b) Calibration check of the RMC.

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

d) Time of mixing of concrete.

e) Testing of fresh concrete, recordings of results and declaring the mix fit or unfit for use. This will include continuous control on the workability during production and taking corrective action. For exercising such control, the Engineer shall periodically depute his authorized representative at the RMC plant. It shall be the responsibility of the contractor to ensure that the necessary equipment manpower & facilities are made available to Engineer and/or his authorized representative at RMC plant.

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

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

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

(i) Control of Purchased Material Quality

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

(ii) Control of Material Storage

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

(iii) Record of Mix Design and Mix Design Modification

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

(iv) Computer Print outs of Each Truck Load

Each truckload/ transit mixer dispatched to site shall carry computer printout of the ingredients of the concrete it is carrying. The printout shall be produced to Engineer-in-Charge or his representative at site before RMC issued in work.

(v) Transfer and Weighing Equipment

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

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

(vii) Production of Concrete

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

- a) Weighing (correct reading of batch data and accurate weighing):- For each load, written, printed or graphical records shall be made of the weights of the materials batched, the estimated slump, the total amount of water added to load the delivery tickets number for that load and the time of loading the concrete into the truck.
- b) Visual observation of concrete during production and delivery or during sampling and testing of fresh concrete assessment of uniformity, cohesion, workability adjustment to water content. The workability of the concrete shall be controlled on a continuous basis during production. The batch mix found unfit shall not be loaded into the truck for transportation. Necessary corrective action shall be taken in the production of mix as required for further batches.
- c) Use of adequate equipment at the plant to measure surface moisture content of aggregates, particularly fine aggregates or the workability of the concrete, cube tests etc. shall also be ensured.
- d) Making corresponding adjustment at the plant automatically or manually to batched quantities to allow for observed, measured or reported changes in materials or concrete qualities.
- e) Sampling of concrete, testing monitoring of results.
- f) Diagnosis and correction of faults identified from observations / complaints.

(viii) The RMC plant produced concrete shall be accepted by Engineer-in -Charge at site after receipt of the same after fulfilling all the requirements of mix mentioned in the tender documents.

- a) The Item of design mix cement concrete is inclusive of all the ingredients including admixtures, if required, labour, machinery T&P etc. required for a design mix concrete of required strength and workability, and, shall take into account change, if any, in quantities of concrete, ingredients like cement and aggregates and admixtures etc. as per the approved mix design.
- b) Ready mix concrete shall be arranged in quantity as required at site of work. The ready mix concrete shall be supplied as per the pre-agreed schedule approved by Engineer-in-Charge.
- c) Frequency of sampling and standards of acceptance shall be as per CPWD specifications.
- d) No addition of water or other ingredients shall be permitted in the RMC at site or during transit.
- e) The RMC shall be placed by pump of suitable capacity and the arrangements shall be made to arrange sufficient length of pipe at site to place the RMC in the minimum required time.
- f) Pre delivery tickets shall be produced with each truck load of RMC.
- g) The representative of RMC supplier shall attend the site meetings as and when decided by the Engineer-in-Charge.
- h) The contractor shall assess the quantity of RMC requirement at site well in advance and order accordingly to the RMC supplier. It shall be the responsibility of the EPC contractor to arrange requisite quantity of RMC available at site, so that there is no hindrance to the work on this account.

4.13 Standard for Acceptance

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

4.14 Ultrasonic Pulse Velocity Method of Test for RCC

- i. The underlying principle of assessing the quality of concrete is that comparatively higher velocities are obtained when the quality of concrete in terms of density, homogeneity and uniformity is good. The consistency of the concrete as regards its general quality gets established. In case of poorer quality lower velocities are obtained. If there are cracks, voids or flaws inside the concrete which come in the way of transmission of pulse, lower velocities are obtained.
- ii. The quality of concrete in terms of uniformity, incidence or absence of internal flaws, cracks and segregation etc. indicative of the level of workmanship employed, can thus be assessed using the guidance given in table below, which have been evolved for characterizing the quality concrete in structure in term of the ultrasonic pulse velocity.
Velocity criterion for Concrete Quality Grading.

Sl. No.	Pulse velocity by Cross Probing (km/sec)	Concrete Quality Grading
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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 carry further tests.

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

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

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

4.15 Cover/Spacer Block

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

5.1 Wooden:

5.1.1 Wood:

a. Timber shall be Forest Stewardship council (FSC) certified wood and it shall be seasoned and preservative treated.

b. The moisture contents of the wood used in the work shall not be more than that stipulated in the relevant clause of Latest CPWD Specifications for works. Kiln seasoning and preservative treatment of wood, if required, shall be done by the contractor. In all other respects the wood used in the work shall conform to the provision in latest CPWD specification for works.

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

5.1.2 Shutters-Wooden-Flush

a. Factory made shutters, conforming to IS 2202 (Part -I) 1977, shall be obtained from factories to be approved by the Engineer-in-charge and. The contractor shall inform well in advance to the Engineer-in-charge the name address of the factory from where the contractor intends to get the shutters manufactured.

b. The contractor will place order for manufacture of shutters only after written approval of Engineer – in – charge in this regard is obtained. The contractor is bound to abide by the decision of the Engineer – in-charge. In case the factory already proposed by the contractor is not found competent to manufacture quality shutters, the contractor shall propose another name of another factory from the approved list for the approval of Engineer – in – charge.

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

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

5.1.3 Hardware

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

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

5.2 Aluminium Works

a. General

i. The scope of the work is the fabrication, supply and erection at site of all types of Aluminium glazed doors, windows and partitions in accordance with the drawings and specifications.

ii. The supply and erection will include all parts such as but not restricted to frames, tracks, guides, mullions, styles, rails, couplers, transoms, rails, plates glazing bars, glass, hinges, arrangement, spring catches, cord and pulley arrangements, spring catches, cord and pulley arrangements door closers floor springs etc., required for the whole work whether the parts/ items are individually and specifically referred to in the schedules/ specifications/drawings or not provided that the supply and installation of such parts can be inferred there from and are necessary to make the work complete, unless separate provision is made in the bills of quantities for supply to such parts/items.

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

b. Materials:-

i. The members will be made out of Aluminum alloy corresponding to IS:733 and will consist of extruded sections and of other shapes, and to sized gauges as shown in the drawings/ described in accordance with the relevant IS codes. The members shall be chosen to provide strength/ stability and maximum resistance to wear and tear.

ii. The Sections will be as per approved makes, extruded sections. As indicated in the drawings the tenderer should specifically mention which sections he is using.

iii. The IS specifications are to be strictly adhered.

iv. The extruder using recycled materials may be preferred.

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

c. Finishing

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

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

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

d. Fabrication

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

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

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

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

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

vi. All fabricated/finished items shall be packed and carted properly to site to prevent any damage in transit. On receipt at site they shall be carefully stacked in protected storage to avoid distortion/damage.

vii. Site installation shall be with concealed screws, self-tapping or other approved fasteners or may be by welding, due precautions shall be taken to avoid any distortion/ discoloration /damage to the finished items.

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

e. Hardware:

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

6.1 Grill Work:

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

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

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

6.2 Railing :

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

a. MS Railing: To be provided as per CPWD specifications as specified in tender drawings and DBR including painting & primer coat complete.

b. Stainless Steel Railing

i.

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

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

iii. The Contractor shall procure and submit to the Engineer-in-Charge, samples of various materials for the railing work, for approval. After approval of samples, the Contractor shall prepare a mock up for approval of Engineer-in-

Charge / OFAJ. The material shall be procured and the mass work taken up only after the approval of the mock up by the Engineer-in-Charge / OFAJ. The mock-up shall be dismantled and removed by the contractor as per the directions of the Engineer-in-Charge. Nothing extra shall be payable on this account.

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

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

vi. One test (three specimens) for each lot shall be conducted for the stainless steel pipe in the approved laboratory. Therefore, the material shall preferably be procured in one lot from one manufacturer.

vii. The finished surface shall be free of any defects like dents, waviness, scratches, stains etc. and shall have uniform brushed steel satin finish. Any defective work shall be rejected and redone by the Contractor at his own cost. The finished surface shall therefore be protected using protective tape which shall be removed at the time of completion of the work. The surface shall then be suitably cleaned using nonabrasive approved cleaner for the material. Nothing extra shall be payable on this account.

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

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

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

7.0 STRUCTURAL STEEL

a. General

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

ii. Fabrication, erection and approval of steel structures shall be in compliance with General Specifications mentioned in CPWD specifications with up to date correction slips and IS: 800 – 2007. For the guidance on general fabrication and erection of structural steel work, Chapter 11 of IS: 800 (1984) must be followed. As far as safety is concerned guidance could be obtained from Indian safety code for structural steelwork IS: 7205(1974). Before the commencement of the erection, all the erection equipment tools, shackles, ropes etc. should be tested for their load carrying capacity. Such tests if needed may be repeated at intermediate stages also.

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

b. Scope

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

c. Fabrication Drawings

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

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

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

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

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

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

d. Materials

i. Rolled Sections

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

ii. Welding Materials

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

iii. Bolts, Nuts & Washers

Bolts and nuts shall be as per IS: 1367 and tested as per IS: 1608. It shall have a minimum tensile strength of 44 Kg/mm² and minimum elongation of 23% on a gauge length of 5.65 (A- Original cross sectional area of the gauge length). Washers shall be as per IS: 2016.

iv. All materials shall conform to their respective specifications. The use of equivalent or higher grade or alternate materials will be considered only in very special cases subject to the approval of the Engineer-in-charge in writing.

v. Receipt & Storing of Materials

•Steel materials supplied by the contractor must be marked for identification and each lot should be accompanied by manufacturer's quality certificate, conforming chemical analysis and mechanical characteristics.

•All steel parts furnished by supplier shall be checked, sorted out, straightened, and arranged by grades and qualities in stores.

•Structural steel with surface defects such as pitting, cracks, laminations etc. shall be rejected if the defects exceed the allowable tolerances specified in relevant standards or as directed by the chief Engineer-in-charge.

•Welding wire and electrodes shall be stored separately by qualities and lots inside a dry and enclosed room, in compliance with IS: 816 - 1969 and as per instructions given by the Engineer-in-charge. Electrodes shall be perfectly dry and drawn from an electrode even, if required.

vi. Checking of quality bolts of any kind as well as storage of same shall be made conforming to relevant standards.

•Each lot of electrodes, bolts, nuts, etc. shall be accompanied by manufacturer's test certificate.

•The contractor may use alternative materials as compared to design specification only with the written approval of the Engineer-in-charge.

vii. Material Tests

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

viii. Fabrication

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

•Preparation of Materials

a. Prior to release for fabrication, all rolled sections warped beyond allowable limit shall be pressed or rolled straight and freed from twists, taking care that a uniform pressure is applied. Minor warping, corrugations etc. in rolled sections shall be rectified by cold working. The sections shall be straightened by hot working where the Engineer-in-charge so direct and shall cooled slowly after straightening.

b. Marking

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

c. Cutting

Members shall be cut mechanically (by saw or shear or by oxyacetylene flame). All sharp, rough, or broken edges, and all edges of joints which are subjected to tensile or oscillating stresses, shall be ground. No electric metal arc cutting shall be allowed. All edges cut by oxyacetylene process shall be cleaned of impurities prior to assembly. The edge preparation for welding of members more than 12 mm thick shall be done by flame cutting and grinding. Cut faces shall not have cracks or be rough. Edge preparation shall be as per IS : 823 - 1964.

d. Drilling

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

- Maximum deviation for spacing of two holes on the same axis shall be + 1 mm.
- Two perpendicular diameters of any oval hole shall not differ by more than 1 mm.

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

f. Welding

i) Preparation of Members for Welding

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

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

- Weld spatter and welding oxides on finished surfaces shall be removed by descaling and / or grinding. Plug, puddle or spot welding shall not be permitted. If weld beads are visible on exposed finished surfaces, the surfaces shall be ground and polished to match and blend with finish on adjacent parent metal. Structural welds shall be made by certified welders and shall conform to I.S. code. The welds shall be tested by the Contractor to ensure quality and integrity of the structural welds. However, welding tests shall be carried out as below: and the contractor shall maintain records for Visual testing – 100% of the welds for size and quality. Fillet weld testing- 30 % of the welds for MPI or Dye penetration test.

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

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

ii) Assembly of structural members

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

iii) Welding procedures

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

bright by light chipping and wire brushing. Backing strips shall not be allowed.

The order and method of welding shall be so that -

- No unacceptable deformation appears in the welded parts.

- Due margin is provided to compensate for contraction due to welding in order to avoid any high permanent stresses. The defects in welds must be rectified according to IS: 823 and as per instruction of Engineer-in-charge.

iv) Weld Inspection

The weld seams shall satisfy the following:

- shall correspond to design shapes and dimensions.
- shall not have any defects such as cracks, incomplete penetration and fusion, under-cuts, rough surfaces, burns, blow holes and porosity etc. beyond permissible limits. The mechanical characteristics of the welded joints shall be as in IS: 823.

v) Preparation of Members for Bolting

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

vi) Bolting up

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

vii) Planing of Ends

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

viii) Holes for Field Joints

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

ix) Marking for Identification

All elements and members prior to dispatch from the fabrication yard for erection shall be shop marked. The members shall be visibly marked with a weather proof light coloured paint. The size and thickness of the numbers shall be chosen as to facilitate the identification of members. For the small members that are delivered in bundles or crates, the required marking shall be done on small metal tags securely tied to the bundle, while the crates shall be marked directly. Each bundle or crate shall be packed with members for one and the same assembly; in the same bundle or crate, general utility members such as bolts, quests etc. may be packed. List of materials showing weight, quality and dimension of contents shall be placed in the crates. The members shall be marked with a durable paint, in a visible location, preferably at one end of the member so that these may be easily checked during storage and erection. All members shall be marked in the shop before inspection and acceptance. When the member is being painted, the marking area shall not be painted but bordered with white paint. The marking and job symbol shall be registered in all shop delivery documents (transportation, for erection etc.)

x) Shop Test Pre-assembly

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

g. Shop Inspection and Approval

i) General

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

h. Painting and Delivery

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

- Surface have been wire brushed, cleaned of dust, oil, rust or sand blasted as per the requirement and direction of Engineer-in-charge etc.

- Erection gaps between members, spots that cannot be painted or where moisture or other aggressive agents may penetrate, have been filled with an approved type of oil and putty.

- The surface to be painted is completely dry.

- The parts where water of aggressive agents may collect (during transportation, storage, erection and operation) are filled with putty and provided with holes for drainage of water.

- Members and parts have been inspected and accepted

- Welds have been accepted.

The following are not to be painted or protected by any other product:

- Surface which are in the vicinity of joints to be welded at site.

Surfaces bearing markings

- Other surfaces indicated in the design.

The following shall be given a coat of hot oil or any approved resistant lubricant only.

- Planed surfaces

- Holes for links

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

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

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

ii) Packing, transportation, delivery

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

- Quality and quantity of structure or members

- Position of member in the structure

- Particulars of structure

- Identification number job symbol.

i. Field Erection

- The erection work shall be permitted only after the foundation or other structure over which the steel work will be erected is approved and is ready for erection.

- The contractor shall satisfy himself about the levels, alignment etc. for the foundations well in advance, before starting the erection. Minor chipping etc. shall be carried out by the contractor on his expense.

- Any faulty erection done by the contractor shall be made good at his own cost.

Approval by the Engineer-in-charge or their representatives at any stage of work does not relieve the contractor of any of his required guarantees of the contract.

- Storage and preparation of parts prior to erection

The storage place for steel parts shall be prepared in advance and got approved by the Engineer-in-charge before the steel structures start arriving from the hop. A platform shall be provided by the Contractor near the erection site for preliminary erection work. The contractor shall make the following verifications upon receipt of material at site.

- For quality certificates regarding materials and workmanship according to these general specifications and drawings.
- Whether parts received are complete without defects due to transportation, loading and unloading and defects, if any, are well within the admissible limit.

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

j. Erection & Tolerances

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

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

- damage during transportation
- accuracy of alignment of structures
- erection according to drawings and specifications
- progress and workmanship.

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

k. Final acceptance and handing over the structure

(i) At acceptance, the contractor shall submit the following documents:

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

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

l. Grouting of Pockets

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

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

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

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

8FALSE CEILING

8.1 General: -

The false ceiling in the buildings shall be as per the approved finishing schedule appended in DBR and as per latest CPWD specifications or manufactures specifications.

- a. False ceiling items in general are carried out as per the manufacturer's specifications / as directed by the Engineer – in – Charge.
- b. Location of particular type of false ceiling shall be as per relevant drawing, in its absence written approval of the Engineer – in - charge shall be obtained.
- c. The false ceiling tiles from manufacturers using recycled materials shall be preferred.
- d. Trap doors, as required, of approved size and design shall be provided.

9. WATER PROOFING

9.1 General :

9.1.1

The Contractor shall be responsible for the water proofing design, proper installation and performance of waterproofing systems to make the sub structure and superstructure completely watertight.

9.1.2

The Contractor shall engage a qualified water proofing specialist sub-Contractor, preferably manufacturer's authorized applicator to carry the water proofing in accordance with the manufacturer's recommendations & approved water proofing details.

9.1.3

For the Quality assurance and quality of workmanship, waterproofing specialist applicator should be proficient in handling and installing water proofing membrane / crystalline compound etc. CIDC certified and trained applicator to be preferred.

9.1.4

Waterproofing specialist applicators should have a proven track record, technical reliability, capability to supply full technical assistance, expert supervision during installation and performance guarantee. The Contractor shall submit the name of his Specialist waterproofing Contractor (waterproofing applicator) for approval along with work experience details.

9.1.5 The waterproofing compounds shall be in accordance with approved make of materials annexed in the contract agreement. The contractor shall get the waterproofing product and its make approved by the Engineer-in-charge. However, this approval shall not exempt the Contractor from responsibility for the success of waterproofing treatment done by him.

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

9.1.7 The contractor shall prepare a sample for demonstration to the engineer-in-charge.

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

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

9.1.10 The Contractor shall get water proofing work done checked by engineer in-charge or his authorized representative by flooding of water for sufficient duration as directed by Engineer-in- charge. However, this approval shall not exempt the Contractor from responsibility for the success of water proofing treatment done by him.

9.1.11 The Contractor, for the work of water proofing, will have to execute a guarantee bond for removing any defects in waterproofing done by it in this contract for 10 years after completion of entire work in the contract agreement.

9.1.12 Material shall be supplied with manufacturer's data sheet, Label, MTC and method statement. The client has the right to inspect the manufacturing facility of the original manufacturer. All manufacturers to provide material test certificate of each lot. Material test certificate of original manufacturer only acceptable, Material statement to be provided by manufacturer.

9.2 Crystalline Water Proofing Compound:

RCC/Concrete work in Raft, Retaining walls, Water tanks, STP, Pump house, Lift pit, Terrace slab, waterproofing protection screed at terrace and other water retaining structures shall be admixed with Crystalline Water Proofing Compound to reduce permeability of concrete in addition to proposed Waterproofing System as per following specifications:

Providing and mixing integral crystalline admixture for water proofing treatment to RCC structures at the time of transporting of concrete into the drum of the ready-mix truck, using integral crystalline admixture @ 0.80% (minimum) to the weight of cement content per cubic meter of concrete) or higher as recommended by the manufacturer's specification in reinforced cement concrete at site of work. The material shall meet the requirements as specified in ACI 212-3R2010 i.e. by reducing permeability of concrete by more than 90%, compared with control concrete as per DIN 1048 and resistant to 16 bar hydrostatic pressure. The crystalline admixture shall be capable of self-healing of cracks up to a width of 0.50mm. The work shall be carried out all complete as per specification and the direction of the Engineer-in-charge. The product performance shall carry guarantee for 10 years against any leakage.

9.3 Waterproofing system in toilets:

9.3.1 Providing and applying Two-part acrylic polymer modified cementitious elastomeric waterproof coating having minimum 1 N/mm² tensile strength, at average 1.5mm thickness DFT, and shall cover 2.00 kg / sqm. The coating shall have an elongation of a minimum of 120% when tested as per ASTM D 412 and having crack bridging ability of up to 2mm. Thorough surface preparation by mechanical means to level and plain the surface of walls and floors of the toilet areas. All cracks and crevices to filled and made good to receive waterproofing coating treatment. The coating shall cover all the floor area of the wet area (toilet) and be applied over on to the vertical walls for required height above the floor. The periphery of the toilet floor shall be additionally reinforced with an extra third coat of the coating with a fibre band sandwiched between the first and the second coat, which shall also be done around protrusions (pipes) meant for plumbing purpose. The last coat when wet, shall be sprinkled with clean and washed sand, to facilitate the floor screed or plaster.

9.3.2 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. Contractor shall submit methodology statement with all detail in illustrative sketch form and get approved from Engineer in charge. Application shall be carried out by approved applicator of manufacture and as per recommended by manufacturer. Applied area of cementitious elastomeric coating (horizontal and vertical) shall be measured for payment.

9.3.3 Method of Application:

- Cleaning the slab to remove loose dust, dirt, oil, debris (sunken slab for toilets or balcony) with water jetting, saturating the slab with water. 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.

- Carry out / making 50 mm thick cement mortar (1:3) and modified with Polymer bonding agent at dosage of 2.5 Litre per 50kg cement.

- 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.

- Applying first coat of Elastomeric Polymer modified cementitious waterproofing compound as primer coat as per manufacturer's specification.

- Laid 45gsm fibre mesh (alkali resistant) on first layer of coating become sandwich between two layers.

- Apply second coat of Elastomeric Polymer modified cementitious waterproofing compound by brush or roller so as fibre mesh is completely covered.

- Coating shall be applied over on to the vertical walls for a height of 4 feet above the floor.

- The last coat when wet, shall be sprinkled with quartz sand, to facilitate proper bonding of the protective screed on floor/plaster on wall and filling light bats in sunken portions. 13.8.4 If required in sunken portions for providing and filling light weight AAC bats (of size 40-60 mm) with cement mortar mixed in the ratio 1:3:6 (1 cement : 3 coarse

sand : 6 block bats) including mixing of approved water proofing compound in recommended proportion. The laid bat mix shall be well rammed and compacted as required. Further surfaces shall be screeded with cement concrete mix 1:1.5:3 (1 cement : 1.5 coarse sand : 3 stone grit of size 6 mm and below by volume) admixed with approved integral water proofing compound in recommended proportion, laid to an average thickness of 25mm and finished smooth or ready to receive finish material as specified. Care shall be taken prior to filling all pipes passing through sunk portion such that the pipes are pressure tested by maintaining pressure for 24 hours and junctions of pipes passing through walls, slabs are well grouted and sealed.

9.4 Waterproofing System for Roof / Terrace Insulation):

9.4.1 Terrace Slabs shall be provided with Elastomeric PU coating composite Waterproofing and Insulation systems as follows:

- Repairing cracks on mother roof slab by cutting & making V grooves in 25x25 mm, and filling with a polymer modified cementitious mortar, of 1:3 proportion and filling the groove with CM (1:3) as recommended by manufacturer specification.
- Surface preparation shall be done as per manufacturer specifications followed by single component PU water proofing coating.
- Making fillet with polymer modified mortar or as per manufacturer of minimum size 50mm x 50mm.
- Applying a base coat of one component polyurethane based waterproofing coating, having elongation > 400%, crack bridging minimum 2 mm, tensile strength of > 2.0 Mpa (as per ASTM D 412), solid content -80% to 90 %, avg. DFT 1.5mm in two coats shall be applied at all the corners above the mother slab of roof and over the concrete haunches provided in the periphery of the slab at the junctions of the parapet wall.
- Spray applying an average 80 mm thick polyurethane foam (CFC and HCFC free), with a core density of 45-50 kg /m³, thermal conductivity of 0.023 W/m.k at 25°C mean temperature (as per ASTM C518-91), tensile strength of > 300kPa (as per ASTM D 1623), compressive strength with rise of >300kPa (as per ASTM D-1621), closed cell content having apparent volume of > 90% (as per ASTM D 6226/ 2856) and fire resistance property conforming to Class B2 as per DIN 4102.
- Supplying and applying a base coat of one component polyurethane based waterproofing coating, having elongation of > 400% and tensile strength of > 2 MPa (as per ASTM D 412) with avg. DFT 1.5mm in two coats over a PU foam.
- Supplying & laying 300 gsm Geotextile (non-woven polyester) over the entire membrane maintaining proper overlaps of 100 mm.
- Applying average 150 mm (to maintaining the required gradient for proper drainage of water and minimum 60mm thick concrete at khurra/ mouth of rain water pipe) thick M25 grade concrete screed admixed with integral crystalline admixture as per recommended dosages for including providing control joints in 3M X 4M grids size and providing the angular haunch of 50mmX50mm using M25 grade concrete at the corners of the slab-parapet wall junctions all around the periphery. Screed concrete shall be cut by mechanical means and filling the groove with a one component (Thermatech) Polyurethane Sealant that is moisture triggered and cast immediately on saw cutting joints on green concrete. The width of sealant fill shall not exceed 10mm. Becker rod along with polysulphide/ Polyurethane sealant shall be provided to seal the saw cut joints.
- Contractor shall submit methodology statement with all detail in illustrative sketch form and get approved from Engineer in charge. All material from single manufacturer. Application shall be carried out by approved applicator of manufacture and as per recommended by manufacturer.

9.4.2 Material:

- PU coating on mother slab – a base coat of one component polyurethane based waterproofing coating, crack bridging ≤ 2 mm, having elongation > 400% and tensile strength of >3 Mpa, applied at 1.5 kg/ sqm (as per ASTM D 412).
- PU Puff insulation - minimum 80 mm thick polyurethane foam, with a core density of 45-50 kg/m³, thermal conductivity of 0.023 W/m.k at 25°C mean temperature (as per ASTM C518/91), tensile strength of > 400kPa (as per ASTM D 1623), compressive strength with rise of >300kPa (as per ASTM D-1621), closed cell content having apparent vol of > 90% (as per ASTM D 2856) and fire resistance property conforming to Class B2 as per DIN 4102.

- PU coating on Insulation – a base coat of two component polyurethane based waterproofing coating, having elongation of >400% and tensile strength of >3 MPa, applied at 1.5 kg/ sqm. (as per ASTM D 412), over a PU foam.

9.4.3 SRI Coating: Providing and applying UV resistant, a spray / roller applied solar reflective cum waterproof coating for terrace area with elastomeric property and having a SRI value not less than 100-105 (as per ASTM E 1980), with crack bridging ability up to 1mm (as per ASTM C 836: 1995) and elongation at break of 200 % (as per ASTM D 412 : 2002), having tensile strength ≥ 1.0 Mpa with a coverage of 1.5 kg / sqm (2 liter per sqm) in 3 coats sandwiched with a fabric between 1st and 2nd coat, entire coating system applied over a primer. The termination of the SRI coating shall be terminated at the drip moulds of the plaster of the parapet wall, above the haunch. After completion of SRI coating, additional lacquer coating shall be applied to achieve a zero dust adherence on the coating so as to maintain the SRI value. Actual applied area shall be measured for payment. SRI coating with total water proofing system 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.

9.5 Water proofing system for UG & OH water tanks

9.5.1 Food grade epoxy coating (approved colour& shade) water proofing system for water tank as per manufacturer specification and as approved by Engineer- In-charge.

9.5.2 Providing and applying food grade epoxy coating treatment to water tank on inside surface after proper surface preparation, carry out cementitious injection grouting at leakage points using Plasticized expansive grout admixture, treatment of construction joints using polymer modified mortar prepared by using SBR Latex-screed modifier cum bonding agent, application of polymer modified vatta/ fillet at floor-wall junction prepared by using SBR, filling pipe cut-outs using Non shrink cementitious grout and hydro swell water bar, application of one coat of epoxy primer and two coats of Solvent free food grade epoxy resin coating in 2 coats etc. complete including all tools and tackles as per manufacturer's specification. Food grade epoxy coating shall be having adhesive bond strength > 1 Mpa, Pot life of 30 min @ 30 °C and cured film shall be non-toxic and shall meet the requirements of IS: 9833:1981. Contractor shall furnish 10 years warranty for the coating. Application shall be carried out by approved applicator of manufacture and as per recommended by manufacturer.

9.5.3 Method of Application

- The cleaning and preparation of the substrate on which the waterproofing coating is applied as follow.
- One coat of primer and two coats of Solvent free epoxy resin coating @ 300 microns DFT in 2 coats.

9.6 Treatment of Pipe Penetrations:

Grouting & Sealing around the periphery joints of pipes passing through the floor and walls in various locations by filling micro concrete of approved manufacturer in the gap between the cut outs in the slab and the pipe surface and sealing around the periphery joints of the pipes using two component (1:1) moisture insensitive epoxy putty conforming to ASTM C882. The waterproofing should be continued over the pipes.

9.7 Grouting & Sealing of faulty construction joints, cracks, tie rod holes, honeycombed concrete surface in RCC UG structures/Water Tanks/ETP/STP etc :

Providing and applying crystalline mortar by mixing in the ratio of 4.5:1 (4.5 parts crystalline mortar: 1 part water) for the treatment of faulty construction joints, cracks, tie rod holes and spalled & honeycombed surface of RCC structures, water tanks, to ensure water tightness. The crystalline mortar shall conform to the EN 1504- 3 having compressive strength Class R4 > 45 MPa and adhesive bond strength Class R3 > 1.5 MPa. The work shall be carried out all complete as per specification and the direction of the Engineer-in- charge. The product performance shall carry guarantee for 10 years against any leakage.

For patching of tie rod holes, preparing tie rod hole surface and then priming the area with integral crystalline slurry @0.070kg per sqm and while the surface is tacky, repairing and then filling the tie rod holes with crystalline mortar @0.040kg per hole. The crystalline mortar shall be tightly rodded into tie rod holes or packed tightly (For 25x25x25 mm tie rod hole, use 0.040 kg to fill the hole)

10 GLASS:

- All glass and shall be verified and coordinate with the applicable Performance requirement.
- All glass shall be accurate sizes with clear undamaged edges and surfaces which are not disfigured.
- Glass shall conform to the quality, thickness and dimensional requirement specified in US Federal specifications DD – G0415C.

d. Heat strengthened glass shall not deviate in surface flatness by more than 0.23 mm with in 260mm of leading or trailing edge, or 0.076 mm in centre. Direction of ripple shall be consistent and is acceptable to Engineer-in-charge. All glass shall be delivered to site with the manufacturer's label of identification attached.

e. Glass shall be free from defect or impurities detrimental to its performance. Defects such as bubbles, waves, spots scratches, spalls, discoloration, visibly imperfect coating, chipping, shall be limited in accordance with the Manufacturer's / trade guidelines. The glass is to be produced in such a way that the rollers will be parallel to what will be the horizontal position of the glass. Glass should be consistent in colour.

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

11 ROADS, PATHWAYS

a) The roads are to be constructed with filling of earth, preparation of sub-grade, sub base WBM/WMM over GSB as specified and finished with minimum Grade M40 RCC 200mm thick and as per IRC code with Vacuum Dewatered concrete. All the main RCC roads are to be constructed as per road section drawings and as per IRC code and CPWD Specifications.

b) Interlocking Pavers

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

12 SAMPLES OF MATERIALS:

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

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

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

13 MISCELLANEOUS:

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

14 TESTS:

Materials brought at site of work shall not be used in the work before getting satisfactory test results for Mandatory tests as per relevant provisions in Latest CPWD Specifications for works. These tests shall be got done from laboratories approved by Engineer-in - charge or the laboratory set up by the contractor at site as per directions of Engineer-in – charge.

CHAPTER – B

TECHNICAL SPECIFICATIONS FOR PLUMBING & SANITARY WORKS

1. Scope of work

The work shall in general conform to the Latest CPWD Specifications. Work under this Contract shall consist of furnishing all labour, materials, equipment and appliances necessary and required. The Contractor is required to completely furnish all the plumbing and other specialized services.

2. Plumbing Fixtures

2.1. General

i. Work under this Part shall consist of furnishing all materials & labour necessary and required to completely install all sanitary fixtures, chromium plated fittings and accessories as required for the work.

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

a. Sanitary fixtures

b. Porcelain or stainless steel sinks

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

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

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

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

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

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

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

2.2. Water Closets

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

a. Wall hung wash down or

b. single or double siphon type

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

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

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

2.3. Health faucet/spray

A chromium plated spray with integral hand control valve and connected to a flexible pipe and angle valve with wall flange and hook are fixed as directed by the Engineer-in charge.

2.4. Wash Basins

- i. Wash basins shall wall mounted type or for under over/counter installation as specified.
- ii. Each basin shall be supported on MS galvanized brackets and the basin securely fixed to wall or under/above counter installation. The design of the brackets shall suit the basin selected and as recommended by the manufacturer.
- iii. Each basin shall be provided with 32 mm dia. C.P. waste with overflow/ pop-up or standard waste with rubber plug and chain, 32 mm dia. C.P. brass bottle trap with CP pipe to wall and flange.
- iv. Each basin shall be provided with a single tap a hot & cold Brass CP mixer with or without pop up waste fittings, 32 mm dia. CP cast brass bottle trap with outlet pipe and wall flange.
- v. The edge between the fixture and the wall or the counter shall be sealed with approved type of poly-sulphide sealant.
- vi. Washbasins shall be fixed at proper heights as per NBC or as directed by Engineer-in charge.
- vii. Each washbasin connection (separately for hot and cold) shall be provided with angle valves with CP wall flange and CP connecting pipe and of required length.

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

3.1. Scope of work

- i. Work shall consist of furnishing all labour, materials, equipment's and appliances necessary and required to completely install all soil, waste, vent and rainwater pipes and fittings as per requirement.
- ii. Without restricting to the generality of the foregoing, the system shall include the following:-
 - a. Vertical and horizontal soil, waste, vent and rain water pipes, and fittings, joints, clamps and connections to fixtures.
 - b. CI Hubless soil, waste & Vent pipe and uPVC rainwater pipes.
 - c. Connection of all pipes to sewer lines at ground floor levels.
 - d. Floor and urinal traps, cleanout plugs, inlet fittings and rainwater heads/Khurras.
 - e. Testing of all pipe lines.

3.2. General requirements

- i. All materials shall be new of the best quality conforming to specifications and subject to the approval of Engineer-in-charge.
- ii. Pipes and fittings shall be fixed truly vertical, horizontal or in slopes as required in a neat workman like manner.
- iii. Pipes shall be fixed in a manner as to provide easy accessibility for repair and maintenance and shall not cause obstruction in shafts, passages etc.
- iv. Pipes shall be securely fixed to walls and ceilings by suitable clamps at intervals specified.
- v. Access doors for fittings and cleanouts shall be so located that they are easily accessible for repair and maintenance.

3.3. Piping System

a. Soil, Waste & Vent Pipes

- i. The Soil& Waste pipe system above ground has been planned as a "two pipe system" as defined in BIS.
 - ii. Vertical soil & waste stacks shall be connected to a common horizontal drain pipe at to an external manhole directly where feasible and shown on the drawings.
- #### b. Rainwater Pipes
- i. All terraces shall be drained by providing down-takes rainwater pipes.
 - ii. Rainwater pipes are separate and independent and are to be connected to the storm water drainage system.
 - c. Hubless centrifugally cast (Span) iron pipes epoxy coated in sides and outside as per IS code 15905.& fittings (for Soil, waste, anti-siphon age pipes)

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

- i. Where specified, Polythene pipes shall be uPVC pipes confirming to I.S: 4985-

2000, 6kg /cm²

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

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

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

f. Jointing

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

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

g. Fittings

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

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

h. Fixing

i. All vertical pipes shall be fixed by structural support clamps truly vertical.

Branch pipes shall be connected to the stack at the same angle as that of the fittings. No collars shall be used on vertical stacks. Each stack shall be terminated at top with a cowl (terminal guard).

ii. Horizontal pipes running along ceiling shall be fixed on structural adjustable clamps (Clevis clamps) of required shape & design or as directed. Horizontal pipes shall be laid to uniform slope and the clamps adjusted to the proper levels so that the pipes fully rest on them.

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

3.4. Traps

a. Floor traps

Floor traps shall be siphon type full bore P or S type Polypropylene having a minimum 50 mm deep seal. The trap and waste pipes shall be set in cement concrete blocks firmly supported on the structural floor. The blocks shall be in 1:2:4 mix (1 cement :2 coarse sand :4 stone aggregate 20 mm nominal size) and extended to 40 mm below finished floor level. Contractor shall provide all necessary shuttering and centring for the blocks. Size of the block shall be 30x30 cm of the required depth.

b. Urinal traps

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

c. Floor trap inlet

Bath room traps and connections shall ensure free and silent flow of discharging water. Where specified, Contractor shall provide a special type inlet fitting of P.P. pipe without, with one, two or three inlet sockets on side to connect the waste pipe.

Joint between waste and hopper inlet socket shall be Ring fit / Drip Seal. Inlet shall be connected to a P.P P or S trap. Floor trap inlet fitting and the traps shall be set in cement concrete blocks.

d. Gratings for traps

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

e. Jointing

Soil, waste, vent and anti-siphonage pipes shall be jointed with Ring fit joint as per design. The following minimum procedures shall be complied with while making the pipe joints:-

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

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

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

iv. Any deformed ends shall be re-rounded.

- v. It shall be ensured that the pipe ends shall enter the fittings and sockets to full depth of the jointing area.
- vi. The pipe work shall be assembled in a manner such that it does not entail making of joints in restricted locations.
- vii. The jointing surfaces shall be cleaned to remove any coatings etc.

f. Floor Trap Inlet/ Inlet Fitting:

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

3.6. Waste pipe from appliances

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

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

c. Polypropylene pipes

Waste pipes from appliances shall be Polypropylene pipe conforming to EN:12056 and quality certificates shall be furnished. Pipes shall be provided with all required fittings e.g. tees, couplings, bends, elbows, unions, reducers, nipples, plugs. All P.P. waste pipes shall be terminated at the point of connection with the appliance with an outlet of suitable diameter.

3.7 Encasing pipe in Cement Concrete

Polypropylene soil and waste pipes under floor in sunken slabs and in wall chases (when cut specially for the pipe) shall be encased in cement concrete 1:2:4 mix (1 cement : 2 coarse sand : 4 stone aggregate 12 mm size) 75 mm in bed and all-round. When pipes are running well above the structural slab, the encased pipes shall be supported with suitable cement concrete pillars of required height at intervals of 1.8 m. inclusive of pillars, supports, shuttering and centring.

3.8 Cutting and making good

a. Pipes shall be fixed and tested as building proceeds.

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

3.9. Testing

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

b. Entire drainage system shall be tested for water tightness during and after completion of the installation. No portion of the system shall remain untested.

Contractor must have adequate number of expandable rubber/bellow plugs, manometers, smoke testing machines, pipe and fitting work test benches and any other equipment necessary and required to conduct the tests. All testing shall be certified for its calibration by an approved laboratory.

c. All materials obtained and used on site must have manufacturer's hydraulic test certificate for each batch of materials used on the site. All testing equipment must be calibrated and shall carry certificate from an approved laboratory.

d. Testing soil, waste and rainwater pipes

i. Apart from factory test all pipes and fittings shall be hydraulically tested for a head of 3 m preferably on a specially set up work bench. After applying pressure, strike the pipe with a wooden pallet and inspect for blow holes and cracks. Pressure may be applied for about 2 minutes. Reject and remove all defective pipes.

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

- iii. The entire installation shall be tested by smoke testing machine. The test can be conducted after the plumbing fixtures are installed and all traps have water seal or by plugging all inlets by bellow plugs. Apply dense smoke keeping the top of stack open and observe for leakages. Rectify or replace defective sections.
- iv. After the installation is fully complete, it should be tested by flushing the toilets, running at least 20% of all taps simultaneously and ensuring that the entire system is self-draining, has no leakages, blockages etc. Rectify and replace where required.
- v. Contractor shall maintain a test register identifying date and time of each area. All tests shall be conducted in presence of Engineer-in-charge and signed by both.

4. Water Supply Systems

4.1. Scope of work

Without restricting to the generality, the water supply system shall include the following:-

- i. Rising main from water supply pumps to all overhead tanks.
- ii. Distribution system from overhead tank to all fixtures and appliances for cold & hot water.
- iii. Connections to all plumbing fixtures, and appliances.

4.2. General requirements

- a. All materials shall be new of the best quality conforming to specifications. All works executed shall be to the satisfaction of the Engineer-in-charge.
- b. Pipes and fittings shall be fixed truly vertical, horizontal or in slopes as required in a neat workmanlike manner.
- c. Short or long bends shall be used on all main pipe lines as far as possible. Use of elbows shall be restricted for short connections.
- d. As far as possible all bends shall be formed by means of a hydraulic pipe bending machine for pipes up to 25 mm dia. Bends and elbows may be used for pipe dia. greater than 32 mm.
- e. Pipes shall be fixed in a manner as to provide easy accessibility for repair and maintenance and shall not cause obstruction in shafts, passages etc.
- f. Pipes shall be securely fixed to walls and ceilings by suitable clamps at intervals approved by the Engineer-In-Charge.
- g. Valves and other appurtenances shall be so located as to provide easy accessibility for operations, maintenance and repairs.

4.3 Pipes & Fittings

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

- i. CPVC pipes shall be used in the internal concealed water supply if specified in the contract. The CPVC pipes shall be conforming to I.S. 15778-2007 and/or ASTM F-441 Schedule 40 of Class specified and having thermal stability for hot & cold water supply and shall be heavy class. These may require to be connected to the existing/ new GI pipes. The pipe and fitting approved make solvent shall be used as per approved manufacture specification.
- ii. Galvanised Iron Pipes shall be used in the external water supply for up to 80mm dia and for above 80mm dia Ductile Iron Pipes shall be used, weather concealed or exposed as per approved design. These shall conform to I.S. 1239 of Class specified and shall be heavy class. These may require to be connected to the existing/ new CPVC/ DI Pipes. The pipe and fitting approved make, solvent etc., as required shall be used as per approved manufacture specification.
- iii. SS 316 pipe shall be provided in labs and specific water supply requirements. The jointing shall be press type fittings with S-C contour in accordance with DVGW regulation W-524 with fittings. A press joint is made by mechanical deformation of the tube and fitting means of special hydraulic tool and cutting of pipe shall also be carried by later cutting tools by authorized agency. An elastomer o-ring is inserted in the recess at the end of the fitting for sealing. When the joint is made, the cross section of the tube becomes hexagonal. A calibration tool is used to ensure that the joint made is up to standard, Clearances from wall, floor and ceiling should be allowed for making the joint refer to the manual of the press tool for clearance requirements.

4.4.1. Galvanised Iron Pipes

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

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

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

iv. All pipes shall be fixed in accordance with approved layout and alignment. Care shall be taken to avoid air pockets. G.I. pipes inside shall be fixed in wall chases well above the floor. No floor shall be run inside a sunken floor as far as possible.

Pipes may be run under the ceiling or floors and other areas as per approved drawings.

4.4.2. Ductile Iron Pipes

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

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

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

4.4.3. Chlorinated Polyvinyl Chloride (CPVC) pipes and fittings

i. CPVC pipes of specified dia. nominal bore shall conform to I.S. 15778 – 2007 and ASTM F-441 Schedule 40. The pipe fittings, clamps, etc. required for specified dia. bore pipes shall be of best quality and make as approved by the Engineer-in-charge. Chlorinated Polyvinyl Chloride (CPVC) pipes shall be as per ASTM F-441 Schedule 40 and having thermal stability for hot & cold water supply, including all CPVC plain & brass threaded fittings, including fixing the pipe with clamps at 1.00 m spacing. This includes jointing of pipes & fittings with one step CPVC solvent cement and testing of joints complete as per direction of Engineer in Charge.

ii. Workmanship:- Pipes shall be cut either with a wheel type plastic pipe cutting or hacksaw blade and care shall be taken to make a square cut which provides optimal bonding area within a joint. Burrs and fittings should be removed from the outside and inside of pipe with a pocket knife or file. The tubing should make contact with the socket wall 1/3 or 2/3 of the way into the fitting socket.

Only CPVC solvent cement conforming to ASTM-F493 should be used for joining pipe with fittings. An even coat of solvent cement should be applied on the pipe end and a thin coat inside the fitting socket. After applying the solvent cement on both pipe and fitting socket, pipe should be inserted into the fitting socket within 30 seconds, and rotating the pipe ¼ to ½ turn while inserting so as to ensure even distribution of solvent cement with the joint. The assembled system should be held for 10 seconds (approximately) in order to allow the joint to set up. An even bead of cement should be evident around the joint and if this bead is not continuous remake the joint to avoid potential leaks.

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

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

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

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

vi. For Horizontal runs, support should be given at 3 foot (90 cm) intervals for diameters of one inch and below and at 4 foot (m) intervals for larger sizes.

Hangers should not have rough or sharp edges which come in contact with the tubing.

vii. All pipes shall be fixed in accordance with layout and alignment shown on the drawings. Care shall be taken to avoid air pockets. CPVC pipes inside shall be fixed in wall chases well above the floor. No floor shall be run inside a sunken floor as far as possible. Pipes may be run under the ceiling or floors and other areas as shown on drawings.

4.4.5. Clamps

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

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

4.4.6. Unions

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

4.4.7. Flanges

i. Flanged connections shall be provided on pipes 65 mm and above as required or where shown on the drawings generally as follows:

a. On straight runs not exceeding 30 m, near bends and at connections to main branch lines.

b. On all valves ends

c. On equipment /pump connections as necessary and required or as directed by Engineer – in - charge.

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

4.4.8. Trenches

i. All water supply pipes below ground shall be laid in trenches with a minimum cover of 60 cms. The width and depth of the trenches shall be as follows:-

Dia. of pipe	Width of trench	Depth of trench
15 mm to 50 mm	30 cm	75 cm
65 mm to 100 mm	45 cm	100 cm

ii. Sandfilling

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

Painting

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

4.4.9. Pipe protection

i. All G.I. pipes in chase or below floor shall be protected against corrosion by the application of two coats of bitumen paint covered with bitumen tape and a final coat of bitumen paint before covering up the pipe.

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

4.5. Valves

i. Ball valves

Providing and fixing ball valve (Gunmetal) of approved quality, High or low pressure, with plastic floats as per drawings/CPWD specifications and directions of Engineer-in-charge. Valves below 50 mm dia. shall be screwed type ball valves with stainless steel balls spindle Teflon seating and gland packing tested to a hydraulic pressure of 20 kg/cm² and accompanying couplings and steel handles to B.S. 5351.

ii. Butterfly Valve

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

b. Valves 50 mm dia. and above shall be cast iron butterfly valve to be used for isolation and/or flow regulation. The valves shall be bubble tight, resilient seated suitable for flow in either direction and seal in both direction. Valves shall be provided with matching flanges with neoprene insertion gasket 3 mm thick .P.N 1.6. Butterfly valve shall be of best quality conforming to IS: 13095.

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

iii. Non return valve (swing check type) shall be provided through which flow can occur in one direction only, It shall be single door swing check type of best quality conforming to IS: 5312.P.N1.6

iv. Each butterfly and slim type swing check valves shall be provided with a pair of flanges screwed or welded to the main line and having the required number of galvanized nuts, bolts and double washers of correct length.

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

4.6. Storage Tanks

4.6.1. Overhead Tanks

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

4.6.2. Tank connection and accessories

i. Contractor shall provide the following to each tanks:

a. Inlet and outlet connections to pumps, equipment and main pipe lines.

b. Tank overflows with mosquito proof gratings

c. Scour drain and valve as per drawings

d. Water level gauge with approved type of brass gauges, plastic tube, a wooden board with level marking.

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

4.7.1. Pipes

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

ii. Workmanship:

The pipes shall be round and shall be supplied in straight lengths with socketed ends. The internal and external surfaces of pipes shall be smooth, clean, free from groovings and other defects. The ends shall be cleanly cut and square with the axis of the pipe. The pipes shall be laid and clamped to wooden plugs fixed above the surface of the wall. Alternatively plastic clamps of suitable designs shall be preferred. Jointing for P.P. pipes shall be made by means of 'O' rubber ring. All soil pipes shall be carried up above the roof and shall have a wire balloon guard or a cowl. The ventilating pipe or shaft shall be carried out to a height of at least one meter above the outer covering of the roof of the building. The P.P. pipes shall be fixed with M. S. clamps and stays. The clamp shall be made from 1.5 mm. thick M. S. flat or 3 mm. width band to the required shape and size to fit tightly on the sockets when tightened with screw bolts. It shall be formed of two semi-circular pieces with flanged ends on both sides; with holes to fit in the screw bolts and nut 40 mm. dia. M. S. Bars. One end of the stay shall be bent to from a hook to be fixed with clamps by means of bolts and the other end shall be bent for embedding in wall in cement concrete block of size 200 mm. x

100 mm. x 100 mm. in 1:2:4 mix. The concrete shall be finished to match the surrounding surfaces. The connection between the main pipe and branch pipes shall be made by using branches and bends with access doors for cleaning. The waste from lavatories, baths and other floor traps shall be separately connected to respective stacks of upper floors. The waste stack of lavatories shall be connected directly to main hole while the waste slack of other shall be separately discharged over gully trap.

4.7.2. P.P. P trap:

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

ii. Workmanship:

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

4.7.3. PP Floor Drain:-

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

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

4.7.4. PP soil, waste water and ventilating pipes :-

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

ii. Workmanship:

The pipes shall be round and shall be supplied in straight lengths with socketed ends. The internal and external surfaces of pipes shall be smooth, clean, free from groovings and other defects. The ends shall be cleanly cut and square with the axis of the pipe. The pipes shall be laid and clamped to wooden plugs fixed above the surface of the wall. Alternatively plastic clamps of suitable designs shall be preferred. Jointing for PP pipes shall be made by means of 'O' rubber ring. The waste from lavatories, kitchens basins, sinks, baths and other floor traps shall be separately connected to respective stacks of upper floors. The waste stack of lavatories shall be connected directly to main hole while the waste slack of other shall be separately discharged over gully trap.

4.7.5. PP Clean out Plug :-

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

ii. Workmanship:- The Clean Out plug shall be made out of PP coupler with access door of suitable size. The Clean out Plug shall be jointed with pipe with 'O' rubber ring.

4.8. CP Materials:-

4.8.1. CP Brass Angle Valve:-

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

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

4.8.2. CP Brass wall mixer:-

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

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

4.8.3. 32 mm dia. C.P. brass waste coupling for sink

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

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

4.8.4

Health faucet with regulator

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

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

4.9.1. UPVC Rain Water pipes

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

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

ii. Workmanship: The pipes shall be round and shall be supplied in straight lengths with socketed ends. The internal and external surfaces of pipes shall be smooth, clean, free from groovings and other defects. The ends shall be cleanly cut and square with the axis of the pipe. The pipes shall be laid and clamped to wooden plugs fixed above the surface of the wall. Alternatively plastic clamps of suitable designs shall be preferred. Jointing for UPVC pipes shall be made by means of solvent cement for horizontal lines and 'O' rubber ring for vertical line. The waste from lavatories, kitchens basins, sinks, baths and other floor traps shall be separately connected to respective stacks of upper floors. The waste stack of lavatories shall be connected directly to main hole while the waste slack of other shall be separately discharged over gully trap.

4.9.2. Cast Iron grating

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

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

4.9.3. MS grating

i. MS grating consisting of ISI marked MS frame made of angle size 25mm x 25mm x 4mm thick. The removable cover shall be made out of ISI marked MS angle size 25mm x 25mm x 4mm thick having vertically welded transverse members made out of MS flats of size 25mm x 5mm thick at a spacing of 25mm centre to centre.

The MS grating, with frame shall be of an approved make including setting in floor with cement mortar 1:3.

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

4.9.4. Reinforced Concrete Light Duty Non-Pressure Pipes

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

ii. Laying: The pipes shall be lowered into the trenches carefully. Mechanical appliances may be used. Where necessary pipe shall be laid in straight lines or with easy curves and true to line and gradient as specified. The laying of pipe shall proceed upgrade of a slope. In the pipe with loose collars, the collars shall be slipped on before the next pipe is laid. In case where the foundation conditions are unusual such as the proximity of trees or holes, under existing or proposed around in 150 mm. thick cement concrete 1 :5 :10 (1 cement: 5 fine sand : 10 graded stone aggregate 40 mm. nominal size) or compacted sand or gravel. In case where the natural foundation is inadequate the pipe shall be laid either in concrete cradle, supported on proper foundation or on any other suitably designed structure. If concrete bedding is used, the depth of concrete below bottom of the pipe shall be at least ¼th of the internal diameter of the pipe subject to a minimum of 100 mm. and maximum 300 mm. The concrete shall be extended up to the sides of the pipe at least a distance of ¼ th of the outside diameter for pipes 300 mm. and over in diameter. The pipes shall be laid in the concrete bedding before the concrete has set. Pipe laid in trenched in earth shall be bedded evenly and firmly and as far as up to the haunches of the pipe as to safely transmit the load expected from the back fill through the pipe to the bed. This shall be done either by excavating the bottom of the trenches to fit the curve of the pipe or by compacting the earth under round curve of the pipe to form an even bed. Necessary provision shall be made for joints wherever required.

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

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

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

4.9.5. 455x610 mm rectangular C.I. cover with (light duty)

- i. The cover for the OHT shall be 455x610 mm rectangular C.I. cover with frame (light duty), with weight not less than 15 Kg for frame and 23 Kg for cover confirming to IS:1726 -1991..
- ii. Workmanship: The CI Cover shall be securely placed on the top of the overhead tank as the case may be in best workman like manner.

4.9.6. Grease Trap

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

ii. Workmanship:

- a. Bed Concrete shall be in 1:4:8 cement concrete 150 mm thick.
- b. Brick work shall be with best quality bricks in 1:5 cement mortar. Baffle walls shall be of R.C.C and of size as mentioned in DBR/Drawings. Brick partition constructed of best quality table moulded bricks in cement mortar 1:5 shall be provided for the entire height of chamber. The walls of chamber shall be plastered from inside with 12 mm thick cement plaster 1:3 and finished smooth with a floating coat of neat cement & rough plaster on outside in cement mortar 1:3.

c. Chamber Covers shall be of size and duty as mentioned in DBR/Drawings.

Covers shall be of cast iron as per the details given in the drawing and shall be fixed on frame embedded in concrete. C. I steps shall be provided at two corners of the chamber. All Cast Iron and MS items shall be painted with two coats of bitumastic paint.

d. Cast iron Manhole covers and Frame shall conform to IS: 1726 and the grade and types have been specified in the DBR/Drawings. The cover and frames shall be cleanly cast and they shall be free from air and sand holes and from cold shuts. They shall be neatly dressed and carefully trimmed. All castings shall be free from voids whether due to shrinkage, gas inclusion or other causes. Covers shall have a raised chequered design on the top surface to provide an adequate non-slip grip. The sizes of covers specified shall be taken as the clear internal dimensions of the frame. The covers and frames shall be coated with a black bituminous composition. The coating shall be smooth and tenacious. It shall not flow when exposed to a temperature of 63° C and shall not brittle as to chip off at a temperature of 0° C

5. LAYING AND JOINTING OF SEWER AND DRAIN PIPES AND FITTINGS

- a) All the Storm Water Piping shall be RCC NP2/NP3 with bedding and up to hunch level with 1:5:10 (40mm aggregate).
- b) All the Sewer and ETP external piping shall be of uPVC SN4 with all around concreting with 1:5:10 (40mm aggregate).

5.1. UNLOADING :

(a) The pipes shall be unloaded where they are required.

(b) Unloading (except where mechanical handling facilities are available) – pipes weighing up to 60 kg shall be handled by two persons by hand passing. Heavier pipes shall be unloaded from the lorry or wagon by holding them in loops, formed with ropes and sliding over planks set not steeper than 45 degree. The planks shall be sufficiently rigid and two ropes shall always be used to roll the pipes down the planks. The ropes should be tied on the side opposite the unloading. Only one pipe shall be unloaded at a time.

(c) Under no circumstances shall be the pipes be thrown down from the carriers or be dragged or rolled along hard surfaces.

(d) The pipes shall be checked for any visible damage (such as broken edges, cracking or spalling of pipe) while unloading and shall be sorted out for reclamation. Any pipe which shows sufficient damage to preclude it from being used shall be discarded.

5.2. STORING :

(a) The pipes and specials shall be handled with sufficient care to avoid damage to them. These shall be lined up on one side of the alignment of the trench socket facing upgrade when line runs uphill and upstream when lines run on level ground.

(b) Each stack shall contain pipes of same class and size, consignment or batch number and particulars of the suppliers, wherever possible, shall be marked on the stack.

(c) Storage shall be done on firm, level and clean ground. Wedges shall be provided at the bottom layer to keep the stack stable.

5.3. CUTTING :

(a) Cutting of pipes may be necessary when pipes are to be laid in lengths shorter than the lengths supplied, such as while replacing accessories like tees, bends, etc. at fixed position in the pipe lines.

(b) A line shall be marked around the pipe with a chalk piece at the point where it is to be cut. The line shall be so marked that the cut is truly at right angle to the longitudinal axis of the pipe.

5.4. LAYING :

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

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

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

5.5. BACK FILLING AND TAMPING :

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

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

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

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

5.6. S. W. GULLY TRAP

5.6.1. MATERIAL :

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

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

5.6.2. EXCAVATION :

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

5.6.3. FIXING :

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

5.6.4. BRICK MASONRY CHAMBER:

After fixing and testing gully and branch drain, a brick masonry chamber 300 mm x 300 mm (in side) with bricks in cement mortar 1:5 (1cement : 5 fine sand) shall be built with a 100 mm brick work round the gully trap from the top of the bed concrete up to ground level. The space between the chamber walls and the trap shall be filled with cement concrete1:5:10 (1 cement : 5 fine sand : 10 graded stone aggregate 10 nominal size). The upper portion of the chamber i.e. above the top level of the trap shall be plastered in side with cement mortar 1:3 (1 cement : 3

sand), finished with a floating coat of neat cement. The corners and bottoms of the chamber shall be rounded off so as to slop towards grating.

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

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

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

5.7.1. MATERIAL :

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

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

Aggregates - The aggregate shall confirm to 3 of IS : 383. The maximum size of aggregate should not exceed one third of the thickness of the pipe or 20 mm whichever is smaller for pipes above 250 mm dia and 10 mm size for pipe dia from 80 to 250 mm.

Reinforcement - The reinforcement shall confirm to mild steel grade 1 or medium tensile steel bars confirming to IS:432 (part 1) or hard drawn steel wire confirming to IS : 432 (part 2) or structural steel (standard quality) bars confirming to IS : 2062. The reinforcement in the reinforced concrete pipes shall extend throughout the length of the pipe. The circumferential and longitudinal reinforcements shall be adequate to withstand the specified hydrostatic pressure and further bending stresses due to the weight of water when running full across a span equal to the length of pipe plus three times its own weight.

5.7.2. JOINTING : SPIGOT AND SOCKET JOINT :

The spigot of each pipe shall be slipped home well into the socket of the pipe previously laid and adjusted in the correct position. The jointing of pipe shall be done by rubber ring method. The rubber rings shall confirm to IS : 5382. A rubber ring shall be placed on the spigot which shall be forced into the socket of pipe previously laid. This compresses the rubber ring as it rolls into the annular space formed between the two surfaces of the spigot and socket, stiff mixture of cement and mortar 1:2 (1 cement : 2 fine sand) shall then be filled into the remaining annular space and rammed with a caulking tool. After days work any extraneous material shall then be removed from inside of the pipe and the newly made joint shall be cured.

5.8. uPVC SN4 Pipe For Sewer and ETP Drain

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

- (A) 160 mm. dia.
- (B) 200 mm. dia.
- (C) 250 mm. dia.
- (D) 315 mm. dia.

5.9. Workmanship:

The pipes shall be round and shall be supplied in straight lengths with socketed ends. The internal and external surfaces of pipes shall be smooth, clean, free from groovings and other defects. The ends shall be cleanly cut and square with the axis of the pipe. Jointing for

UPVC pipes shall be made by means of solvent cement for horizontal lines and 'O' rubber ring.

5.10. TRENCHES :

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

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

(iii) The width of the trench shall be D+400 mm with a minimum of 750 mm. (D= External diameter of pipe).

Note : The width should not be more than the mentioned for structural safety of the pipes.

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

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

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

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

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

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

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

5.11. LAYING :

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

The Cement Concrete bedding shall be provided below RCC / uPVC pipes as instructed by the Engineer-in-charge. When the pipe is laid in a trench in rock hard clay, shale or other hard material the space below the pipe shall be excavated and replaced with an equalizing bed of concrete, sand or compacted earth. In no place shall pipe be laid directly on such hard material.

5.12. TESTING OF JOINTS :

5.12.1. HYDRAULIC TEST :

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

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

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

5.12.2. RECTIFICATION OF FAULTY JOINTS :

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

5.13. MANHOLES

Manholes of different types and sizes specified shall be constructed in the sewer line at such places and to such levels and dimensions as shown in the drawing or as directed by the Engineer-in-charge. The size specified shall indicate the inside dimensions (between wall faces) of the manholes. The branch sewer should deliver sewage in the

manhole in direction of main flow and the junction must be made with care so that flow in the main is not impeded. No drain from house fitting i.e. gully taps or soil pipes etc. to manholes shall normally exceed a length of 6 meter unless it is unavoidable.

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

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

Manholes shall be built to the following specifications :-

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

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

c) Plaster : The inside of wall shall be plastered by 12 mm thick with cement mortar 1:3 (1 cement : 3 coarse sand) and finished with a floating coat of neat cement. All angle shall be rounded to 7.5 cm. radius and all rendered internal surfaces shall have impervious finish obtained by using a steel trowel. Where the saturated soil is met with, also the external surface of the walls of the manhole shall be plastered with 12 mm thick cement plaster 1:3 (1 cement : 3 coarse sand) finished smooth up to 30 cm above the highest sub-soil water level with the approval of the Engineer-in-charge. The plaster shall further be water proofed with addition of approved water proofing compound in a quantity as per manufacturer's specifications.

d) Channels and benching : Channels shall be semi-circular in the bottom half and of diameter equal to the sewer. Above the horizontal diameter, the sides shall be extended vertically to the same level as the crown of the outgoing pipe and the top edge shall be suitably rounded off. The branch channels shall also be similarly constructed with respect to the benching but at their junction with the main channel on appropriate shall suitably rounded off in the direction of flow in the main channel shall be given. The channels and benching shall be done in cement concrete 1:2:4 (1 cement : 2 coarse sand : 4 graded stone aggregate 20 mm nominal size) rising at a slope of 1 in 6 from the edges of channel. The channels of the bottom of the chamber shall be finished with the floating coat of neat cement.

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

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

5.14 TESTING :

Manholes shall be tested by filling with water to a depth not exceeding 1.2 meter as directed by the Engineer-in-charge. After completion of the work manhole covers shall be sealed by means of thick grease.

5.15 CONNECTION TO EXISTING SEWER :

The connection to an existing sewer shall, as far as possible, be done at the manholes. Breaking of sewer shall be effected by the cautious enlargement of sewer hole and every precaution shall be taken to prevent any material from entering the sewer. No connection shall be former in such a way so as to constitute a projection into the sewer or to cause any diminutions in its effective size.

5.16. PRECAST CONCETE MANHOLE COVERS & FRAMES

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

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

a) LD – 2.5 Rectangular, Square or Circular types :

These are suitable for use within residential and institutional complexes / areas with pedestrian but occasional LMV traffic. These covers may also be used for inspection chambers.

b) MD – 10 : These are suitable for use in service lanes / roads, car parking areas etc.

c) MD – 20 : Suitable for use in institutional/commercial areas / carriage ways with heavy duty vehicular traffic like buses, trucks, etc. for a wheel load between 50 to 100 KN.

d) EHD – 35 : Circular, square, or rectangular (scraper manhole) types -

These are suitable for use on carriage way in commercial industrial / port areas / near warehouses / godowns where frequent loading and unloading of trucks / trailers are common, with slow to fast moving vehicular traffic of the types having wheel loads upto 115 KN, irrespective of the location of the manhole chambers.

iii. **MATERIALS :**

(i) Cement : Cement used for the manufacture of precast concrete manhole covers shall conform to IS : 269 or 455 or 1489 or 6909 or IS : 8041 or IS : 8043 or IS : 8112.

(ii) Aggregates :

The aggregates used shall be clean and free from deleterious matter and shall conform to the requirements of IS: 383-1970. The aggregates shall be well graded and the nominal maximum size of coarse aggregate shall not exceed 20 mm.

(iii) Concrete : The mix proportions of concrete shall be determined by the manufacturer and shall be such as will produce a dense concrete without voids, honey combing etc. (IS : 456) The minimum cement content in the concrete shall be 360 kg/m³ with a maximum water cement ratio of 0.45. Concrete weaker than grade M-30 (design mix) shall not be used. Compaction of concrete shall be done by machine vibration.

(iv) Reinforcement : a) The reinforcement steel shall conform to Grade A of IS : 2062 or IS 432 (Part I) or IS : 432 (Part 2) or IS : 1786 as appropriate. Reinforcement shall be clean and free from loose mills scale, loose rust, and mud, oil, grease or any other coating which may reduce or destroy the bond between the concrete and steel. A light film of rust may not be regarded as harmful but steel shall not be visibly pitted by rust.

b) **Fibers steel :** In association with in the main steel bars reinforcement steel fibers of appropriate types and forms may also be used as secondary reinforcement (upto 0.5% by volume).

iv. **SHAPES AND DIMENSIONS :**

The shapes of precast concrete manhole covers shall be square, rectangular or circular with in direction of Engineer In charge.

v. **LIFTING DEVICE :**

The minimum diameter of mild steel rod used as lifting device shall be 10 mm for light and 12 mm for medium duty covers and 16 mm for heavy and extra heavy duty covers. The lifting device shall be protected from corrosion by not galvanizing or epoxy coating or any other suitable.

vi. **FINISHING AND COATING :**

To prevent any possible damage from corrosion of steel the underside of the covers shall be treated with anticorrosive paint. The top surface of the covers shall be given a chequered finish. In order to protect the edges of the covers from possible damage at the time of lifting and handling it is necessary that the manhole covers shall be cast with a protective mild steel sheet of minimum 2.5 mm thickness around the periphery of the covers. Exposed surface of mild steel sheet shall be given suitable treatment with anticorrosive paint or coating.

vii. **PHYSICAL REQUIREMENTS :**

a) General : All units shall be sound and free from cracks and other defects which interface with the proper placing of the unit or impair the strength or performance of the units. Minor chipping at the edge / surface resulting from the customary methods of handling during delivery shall not be deemed for rejecting.

viii. FIXING : The frames of manhole shall be firmly embedded to correct alignment and level in RCC slab or plain concrete as the case may be on the top of masonry which shall be paid as extra unless specified otherwise.

6. Water Supply Pumping System & Allied services

6.1. Scope of work : The scope of work shall consist of furnishing all labour, materials, equipment and appliances necessary and required for the satisfactory supply, installation, completion and commissioning of water supply pumping system and allied works as described in the scope work and as specified in the DBR and described in the scope of work .

6.2. The System : The system described below is for the contractors bidding for the works to understand the extent and scope of work and the intent in the manner in which the water supply system is planned and shall be executed.

i. Sources of supply : The external water supply shall be met from GSR.

ii. Rising Mains & level control system

a. Water from the pumps will fill overhead tank by a rising main.

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

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

6.3. Level Controllers

a. Overhead tank level controller cum indicators & motorized butterfly valve

i. Each OHT to be provided with required number of stainless steel electronically operated probes (housed in a stainless steel protective housing) and connected by a control cable to a central junction box connected to MCC panel. The probes will function as follows:

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

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

iv. Indicate the water level in each OHT in the level indicating panel installed in the pump room

v. Each OHT shall also provided with a motorized butterfly valve complete with high and low level control switches to control the valve. The level controllers shall be installed in overhead tanks. The level switch will close the valve when water level is high (Top Water Level) in over head tank and open the valve when over head water tank level is low (30% of storage capacity). The system should be complete in all respects with accessories, 220 V AC / 24 V DC, IP67 electrical water level control unit, copper control wiring in whether proof casing etc to stop the supply in individual OHT when level reaches a cut off high level.

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

i. A centralized indicating stand-alone wall mounted panel fabricated from with MS sheet and painted inside and outside with stove enamelled finish with clear vertical panels shall indicate water level in each tank by means of digital display unit to indicate water level in each tank in four levels ($\frac{1}{4}$ th, $\frac{1}{2}$, $\frac{3}{4}$ and full). The panel shall be installed on the control console panel located in the pump room or as directed by the Engineer-In-Charge. The panel shall have:

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

iii. Etched plate identification plates.

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

v. Cabling from PHT sensing probes to the panel

6.4. Pipes & Fittings

i. Headers, piping and connections

a. All pipes within the plant room building in exposed locations and shafts including connections buried under floor and for suction and delivery headers shall be D.I /

G.I. / CPVC pipes (medium class) and thickness specified. Pipes up to 150 mm dia. shall conform to I.S. 1239.

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

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

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

ii. Jointing

a. D.I./G.I. Pipes (Screwed joints)

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

b. Flanged joints / Dead Joints

Flanges shall be provided on:

i. Straight runs not exceeding 12-15 m on pipe lines 80 mm dia and above.

- ii. Both ends of any fabricated fittings e.g. bends, tees etc. of 50 mm dia or larger diameter. (When Permitted)
- iii. Both end of all suction delivery and other headers.
- iv. For jointing valves, appurtenances, pumps, connections with pipes, to water tanks and other places necessary and required as good for engineering practice.
- v. Flanges shall be as per applicable I.S. with appropriate number of D.I/G.I. nuts and bolts, 3 mm insertion rubber gasket complete.

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

d. Vibration Eliminators :All suction and delivery lines and as shown on the drawings double flanged reinforced neoprene bellow type flexible pipe connectors shall be provided.

Connectors should be suitable for a working pressure of each pump and tested to the test pressure given in the relevant head. Length of the connectors shall be as per site requirements in accordance with manufacturer's details.

iii. Valves

a. Sluice valves

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

b. Butterfly Valves (PN 1.6 rating)

- i. Butterfly Valves shall be used in all other locations as required conforming to IS 13095.PN 1.6
- ii. They shall have a cast iron body.
- iii. Disc shall be CI heavy duty electrolyses nickel plated abrasion resistant.
- iv. The shaft to be EN-8 Carbon Steel with low friction nylon bearings.
- v. The seat shall be drop tight constructed by bonding resilient elastomerrigid backing.
- vi. Built in flanged rubber seals.
- vii. Actuator to level operated for valves above ground and T Key operated for valves below Ground.
- viii. Built in flanges for screwed on flanged connections. Manufacturer's details on fixing and Installation will be followed.

c. Non Return Valves (NRV PN 1.6 rating))

- i. Non return valves will be used at location to allow flow only in one direction and prevent flow in the opposite direction.
- ii. NRV shall be cast iron slim type with cast iron body and gunmetal internal parts and accompanying flanges. Valves shall conform relevant IS or match the butterfly valves.PN 1.6
- iii. Built in flanges for screwed on flanged connections.

d. Ball Valves

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

CHAPTER – C

TECHNICAL SPECIFICATIONS FOR SPECIFICATION FOR ELECTRICAL WORKS

1.0 GENERAL REQUIREMENTS

The installation shall generally be carried out in conforming with the requirements of the Indian Electricity Act, 1910 as amended up to date and the Indian Electricity Rules, 1956 framed there under, the relevant regulations of the Electric Supply Authority concerned, and also with the specifications laid down in the Indian Standard I.S. 732 - 1963 Code of Practice (Revised) for Electrical Wiring Installations (system voltage not exceeding 650 volts) and I.S. 2309-1969 Code of Practice for the protection of Buildings and Allied Structure against Lightning and IS 3043 - Indian code of Practice for Earthing. The wiring shall also be according to the I.S specifications, NEC, Local Government Body. Only the contractor having valid Electrical Contractor Licence of the state or central issuing departments shall be eligible to execute the same. The contractor shall be responsible for renewal of the same at the appropriate time.

2.0 MATERIALS

All materials, fittings, appliances, used in electrical installations, shall conform to Indian Standard Specifications wherever these exist. A list of approved materials is attached afterwards. Materials not included in the list shall be got approved by the Engineer-in-Charge prior to actual use.

3.0 MAIN SWITCH GEAR

Iron clad switch fuse and isolator units should conform to relevant I.S. Standard. The quick make and break mechanism shall be self interlocked with the cover. In "Off" position there must be two breaks per pole. Main switch gear shall be properly earthed with two numbers conductors if M.V and one number of L.V.

4.0 DISTRIBUTION BOARDS

These totally enclosed metal clad type Distribution Boards with hinged lids shall be in accordance with I.S. 2147 - 1952 and 2675 - 1966 and B.S. 214 and shall be of welded construction and fabricated from rust proofed sheet steel and finished with anticorrosive stove enamel paint and have provision for fixing on wall and have earthing terminals/terminals.

Power Distribution Boards (400 volts TPN) shall be constructed from 16 SWG sheet steel and Branch Distribution Boards (230 volts SPN from 18 SWG sheet steel).

The MCB shall be mounted on Din rails supports of proper dielectric & mechanical strength. If fuses/fuse banks are used these shall be mounted on moulded DMC/SMC or ebonite supports of proper dielectric and mechanical strength. TPN units should have phase separation barriers.

Cables shall be connected to a terminal by crimped lugs.

Where two or more B.D.B's feeding low voltage circuits are fed from different phases of a medium voltage supply, these B.D.B's shall be installed atleast two metres apart or otherwise in a different direction to prevent access to the both DBs at a time.

All three phase power distribution boards shall be properly earthed with two number 25 x 5 mm galvanised iron Flats and provided with suitable Danger Board. All SPN B.D.B's shall be properly earthed with one number 10 SWG galvanised iron wire each or with insulated copper PVC wire of adequate ratings in case of concealed wiring as per the specifications.

5.0 SWITCHES

All switches for lights, fans and plug points shall be piano type switches, unless specified otherwise.

6.0 CABLES AND CONDUCTORS

All cables shall conform to I.S-692, IS-7098, IS-1554 (Part-I) 1964 and IS 694-1990 or latest . Conductors of all cables except for flexible cables, shall be of aluminium, unless specified otherwise.

7.0 FLEXIBLE CABLES

Conductors of flexible cables shall be of copper. The minimum size of core acceptable is 1.50 sq.mm.

8.0 INSTALLATION OF MAIN SWITCH BOARD, DB'S MAINS, SUB-MAINS, DISTRIBUTION WIRING TO INDIVIDUAL POINTS

The exact positions of all main switch board, DB's and all runs of mains and submains, and distribution wirings to individual points including the exact position of all light fittings and switch boards shall be first marked on the buildings and shall be approved by the Engineer-in-Charge before actual commencement of the work.

The D.Bs shall generally be installed at a height of 2.0 m from floor level.

9.0 INSTALLATION OF SWITCH BOARDS

These shall be installed at a height of 1.3 mtrs (4'-3") and above the floor level.

10.0 INSTALLATION OF CEILING FANS

Unless otherwise specified all ceiling fans shall be hung not less than 2.75 M (9 ft) above floor. The suspension and clamp shall be painted with approved paint without involving extra cost.

11.0 INSTALLATION OF LED TUBELIGHT AND RECESS MOUNTED LIGHT FITTINGS :

Where these are suspended from ceiling by two down rods, or fixed to ceiling/beam directly, at least one fixing to the ceiling/beam shall be made with Mechanical/Metal fasteners. Electrical drill only shall be used while making holes for the fasteners which shall be capable of sustaining at least 15 kg of dead weight.

The down rods and accessories shall be painted with approved paint without involving extra cost.

Unless otherwise specified these should be suspended 2.60 M (8'-6") above the floor or as per direction of Owner/Architect to match interiors.

12.0 INSTALLATION OF EXHAUST FANS

Exhaust Fans shall be fitted by means of rag bolts embedded or on suitable size block board (12 mm thick) in the wall/window panels. The required holes in the wall shall be made and finished neatly with cement plaster and brought to the original finish of the wall. In case of block board mounting all fixing, cutting shall be made by the electrical contractor in coordination with civil/interior decoration contractor without extra cost.

13.0 INSTALLATION OF SOCKET OUTLETS

Socket outlet at locations other than bath rooms shall be either 25 cms (10") or 130 cms (4'-3") from the floor.

14.0 TESTING OF INSTALLATION

Before a completed installation or an addition to an existing installation is put into service, the following tests shall be carried out by the contractor in presence of the Engineer-in-Charge/Owner/Architects.

a) Polarity of switches: It must be ensured by test that all single pole switches have been fitted on the live side of the circuits they control.

b) Insulation Test: i) By applying a 1000 volt megger between earth and the whole system of conductors or any section thereof, with all fuses in place and all switches closed, all lamps in position or both poles of installation otherwise electrically connected together :- The result in megaohm shall not be less than 50 divided by the number of points on the circuit, and should not be less than 1 megaohm.

ii) Between all conductors connected to one phase and all such conductors connected to the neutral or to the other phase conductors of the supply after removing all metallic connections between the two poles of the installation and switching on all switches. The insulation resistance shall be as in (i) above.

c) Earth continuity Test: The earth continuity conductor including metal conduits, and metal sheaths of

cables in all cases shall be tested for electrical continuity. Electrical resistance of the above along with the earthing lead but excluding any resistance of earth leakage circuit breaker, measured from the connection with the earth electrode to any point in the earth continuity conductor in the completed installation shall not exceed one ohm.

d) Earth Resistance Test: To ensure effectiveness of installation earth, the value of earth resistance shall be within 5 ohm for installation capacity upto 5 KW and one ohm for installation of higher capacity.

15.0 The completed work will be taken over only if the results obtained in above tests are within the limits mentioned above, and in accordance with I.E. Rules.

On completion of the installation work, a certificate shall be furnished by the contractor, countersigned by the certified supervisor under whose direct supervision the installation was carried out.

16.0 SPECIAL SPECIFICATIONS:

- a) Before fixing all switches, fittings etc. these should be produced before Engineer-in-Charge and get approved.
- b) All metal switch boards and switch/regulator boxes to be used in work shall be painted with two coats of anti rust primer (red oxide paint) prior to erection. After erection these shall be again painted with two coats of enamel paint of approved quality and shade.
- c) Before execution of any portion of conduit work for wiring a neat proper layout should be made out by the contractor and got approved from the Engineer-in-Charge. For this purpose contractor is advised to get acquainted with the layout drawings.
- d) While laying the conduits for concealed wiring in the ceilings/beams/columns/walls/ partitions/modular furniture etc, the contractor must ensure that all the inlets and both ends of the conduits are plugged to stop entry of foreign materials so that no difficulty arises during drawing of wires later .
- e) Damage to any fitting during erection and before handing over the installation by contractor shall be set right or replaced by the contractor at his own cost.
- f) Caution Board of proper size wherever required, shall be provided, as per I.E.E. regulations for which no extra payment will be admissible.
- g) Any repairs done to wall etc. should match with the surrounding surface otherwise same will be got done through Building Contractor at the cost of the Electrical Contractor.
- h) Earthing Installation shall be done in the presence of Engineer-in-Charge or his representative.
- i) The installations should not be energized without adequate earthing.
- j) The I.C. switches and Distribution Fuse Boards shall be provided with neat lettering in block letters with paint for identification of the I.C. switches and for the points connected to each fuse way of the D.B's for which no extra payment will be admissible.
- k) Completion Drawings: The contractor shall be required to submit along with Final bill, the undernoted drawings on tracing papers, along with three copies of Ammonia print each.

1 Plan (as per structural drawing) of each floor (not less than 1:100 metric scale) showing :-

- i) Location of Main Switch Board, Distribution boards (with the circuit numbers controlled by them).
- ii) The runs of mains and submains.
- iii) Location of lights, fans, wall sockets, other power consuming devices together with type of fittings and fixtures including circuit numbers.
- iv) Position of Lightning Conductors and route of running conductor.
- v) Position of Earthing Stations for light and power and Lightning Conductor Installation.
- vi) Following information are to be given on all the drawings :
 - a) Name of work with job no. Accepted Tender No.
 - b) Date of completion
 - c) Name of Place
 - d) Name and Signature of Contractor
 - e) Scale of Drawings.

2 Schematic lines layout diagram of each floor showing (i) Layout and connections of Main and Sub-board, B.D.B. having descriptions of the size, capacity, type and their numbers, the system and the source of supply, (ii) Location, Size, Type, length of main and sub main cables (iii) Loading of each B.D.B. indication of phases, Departmental mark on each B.D.B and switchgear.

The drawings shall be very neatly drawn and submitted properly without folding them.

3. Cable route should be marked on site plan with measurements from permanent structures.

TECHNICAL SPECIFICATION FOR CONDUIT WIRING SYSTEM

1.0 TYPE AND SIZE OF CONDUIT

All conduit pipe shall be screwed type, solid drawn or welded and with black stove enamelled surface or galvanised and of thickness conforming to IS : 9537 Part II of 1981 (or latest revision) in all respects. The conduits are to be free from burrs and internal roughness. No conduits less than 20 mm in dia shall be used, unless specified.

2.0 ACCESSORIES

Only screwed type of accessories are to be used.

3.0 CONDUIT JOINTS

The conduit shall be properly earthed. In long distance straight runs of conduit inspection type screwed couplers are to be provided at reasonable intervals on running threads with couplers and jamnuts. Threads on conduit pipes in all cases shall be between 13 mm to 27 mm long sufficient to accommodate pipes to full threaded portion of couplers or accessories. Cut end of conduit pipes shall have no sharp edges or any burrs left to avoid damage to insulation of conductor while pulling them through such pipes.

4.0 PROTECTION AGAINST DAMPNESS AND RUST

In order to minimise condensation and sweating inside the tube, all outlets of pipes system shall be properly drained and ventilated, but in such a manner as to prevent entry to insects inside the conduit. To protect against rust the outer surface of the conduit and accessories shall be painted and the bare thread portion is to be painted with anti-corrosive preservative.

5.0 FIXING OF CONDUITS

Conduit pipes shall be fixed by heavy gauge saddles and or fibre/metal fasteners as applicable, secured to wall/ceiling by screws driven into synthetic fibre plugs or rawl plugs or phil plugs at an interval of not more than 76 cm apart for vertical run and 60 cm apart for horizontal run. But on either side of couplers or bend of similar fittings-saddle shall be fixed at a distance of 30 cm from the centre of such fittings. The minimum thickness for saddles shall be 24 SWG for conduits upto 25 mm dia, and 20 SWG for larger sizes.

6.0 BENDS IN CONDUITS

All necessary bends in the system including diversion shall be done by bending the pipes, or by inserting suitable inspection type bends, elbows or similar fittings, or by fixing cast iron inspection boxes whichever is most suitable.

7.0 OUTLETS

All outlets for fittings, switches etc. shall be fixed on boxes of suitable metal for either surface mounting system or flush mounting system. In case of cast iron boxes the wall thickness shall be at least 3 mm and in case of welded mild steel sheet box the wall thickness shall not be less than 16 gauge. Except where otherwise stated 3 mm thick insulated laminated sheets shall be fixed on the front with screws. Where conduits are terminated special care shall be taken in employing double jam nuts, for securely fixing conduits to outlets so as to prevent any possibility of damages to cables when drawn.

8.0 CABLES TO BE USED

Unless stated otherwise only single core FRLS Type PVC insulated cables of approved manufactures shall be used for wiring in conduit system. The number of single core cables drawn in one conduit shall not be greater than maximum set out in Table II of Indian Standard (I.S. 732-1963) Code of Practice (Revised) for electrical wiring installation (system voltage not exceeding 650 volts).

9.0 LOOPING IN SYSTEM

Distribution wiring in conduit to light, fan plug points etc shall be done in looping system. In this system no joints or connections shall be made anywhere of the system except at terminating points such as at terminals of switches,

ceiling roses, etc and in case of socket outlets at the socket terminals.

10.0 EARTHING CONTINUITY WIRES

All three pin 6 Amps plug points and metallic fan regulator cover should be provided with earthing attachment by NO. 14 SWG G.I. wires for surface wiring and 1 no. 1.5 Sq.mm PVC insulated copper wire for concealed wiring, unless specified otherwise.

Three pin 16 Amps power plug point should be provided with earthing attachment by No. 14 SWG G.I. wire for surface wiring and 1 no. 2.5 sq.mm PVC insulated copper wire for concealed wiring, unless specified otherwise.

Conduits and accessories for surface distribution wiring should be provided with earthing attachment by 14 SWG G.I. wire, unless specified otherwise.

For looping earthing G.I. wire shall be run on conduits being fixed with saddles. This wire shall not be normally visible after installation when run with the conduit. Where the wire has to be taken without the conduits this will be fixed with 'U' nails at 2' feet intervals.

11.0 PAINTING

Conduit and all conduit fittings and accessories shall be painted with two coats matt paint. Painting of conduits shall be done to harmonize with colour of bearing surface i.e. wall, joists, trusses etc. after installation and as approved by the Engineer-in-Charge.

TECHNICAL SPECIFICATION FOR CONCEALED CONDUIT WIRING SYSTEM

Concealed conduit wiring system shall comply with all requirements for surface conduit wiring system as specified above and in addition conform to the requirements specified below :

1.0 MAKING OF CHASE

The chase in the wall shall be neatly made and be of ample dimensions to permit the conduit to be fixed in the manner desired.

2.0 FIXING OF CONDUIT IN CHASE

The conduit shall be fixed by means of staples, J-Hooks or by means of saddles not more than 60 cm apart. Fixing of standard bends or elbows shall be avoided as far as possible with a long radius bend which will permit easy drawing in of conductors. All threaded joints of metallic conduits shall be treated with some approved preservative to secure protection against rust.

3.0 INSPECTION BOXES

Suitable inspection boxes shall be provided when necessary to permit periodical inspection and to facilitate removal of wires. These shall be mounted flush with wall.

For longer runs of conduit involving more than one bend, one inspection box/draw-in box shall be used after one bend.

4.0 TYPES OF ACCESSORIES TO BE USED

All outlets such as switches, socket outlets, shall be flush mounting type with cast iron or MS boxes with a cover of approved insulating material. The switches and other outlets shall be mounted on such boxes as would be approved. The metal box shall be efficiently earthed with conduit by means of earthing attachment with suitable size of PVC insulated copper wires, running inside the conduit.

5.0 CONDUITS

- i) Steel-Black enamelled thread type M.S. conduits with thickness conforming to IS 9537 Part II of 1981 (or latest revision) with heavy duty accessories and FRLS type PVC conduits conforming to IS 9537 Part-III of 1981 (or latest revision) with PVC accessories shall be used as applicable and specified in BOQ.

For roof slabs - These shall be pre-laid during casting of floor/roof slab. No. of wires drawn through the same

shall not exceed the number of specified I.S. Code.

For vertical drops in wall to switch boards - Minimum size shall be 20 mm.

ii) Maximum capacity of conduits for drawing in of PVC insulated cables shall be as follows :

650/1100V PVC copper wire	In 20 mm dia conduit	In 25 mm dia conduit	In 32 mm dia conduit
1.5 sq.mm	4 Nos	8 Nos	12 Nos
2.5 sq.mm	3 Nos	6 Nos	10 Nos
4.0 sq.mm	2 Nos	6 Nos	8 Nos
6.0 sq.mm	-	5 Nos	7 Nos
10.0 sq.mm	-	3 Nos	5 Nos

Maximum number of PVC insulated 650/1100V grade aluminium/copper conductor cable are as per CPWD General Specification of Electrical Works Part-I (Intern), Page 41, 1994.

TABLE-I

Maximum number of PVC insulated 650/1100V 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
1.50	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
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

Note :1) The above tables shows the maximum capacity of conduits for a simultaneous drawing in of cables.
 2) The columns headed 'S' apply to runs of conduits which have distance not exceeding 4.25 m between draw in boxes and which do not deflect from the straight by an angle of more than 15 degrees. The columns headed 'B' apply to runs of conduit which deflect from the straight by an angle of more than 15 degrees.
 3) Conduit sizes are the nominal external diameters.

1.0 FISH WIRE

18 SWG GI wire shall be used and it shall protrude the conduit ends by 9 inches.

2.0 CONDUIT LAYING IN FLOOR/ROOF SLABS BEFORE CASTING

PVC/Polythene/GI conduit shall be laid straight as far as practicable and properly placed including binding with the

steel reinforcement rods with 22 SWG GI wire so that proper positions of conduits are maintained.

While laying the conduits for concealed wiring in the ceiling or in the beams and columns and before casting, the contractor shall ensure that both ends of the conduit are plugged by means of dead-end socket or otherwise so that any foreign matter can not enter the conduit and choke them.

All precaution must be taken while laying the conduits on the slabs, R.C. walls, columns etc. and the contractor shall rectify at his own cost if any defects are found during process of drawing cables through the concealed prelaidd conduits.

Each PVC/polythene conduit shall be provided with protruding length of not less than 9 inches on free end of the conduits.

There shall be no intermediate joints in one straight run of conduit.

All ceiling outlets shall be terminated in a round CI/GI circular box/deep box to suit standard size ceiling rose or/and rectangular C.I./M.S. junction box or Fan Hook Box as the case may be.

It will be mandatory for the contractor to get the layouts approved by the Engineer-in-Charge/Architect when the conduits are laid and bound to steel reinforcement rods, before he can release the work for casting of floor/roof.

3.0 CONDUCTOR BOXES, DRAW-IN-BOXES : JUNCTION BOXES

These shall be constructed from 16 SWG M.S. sheet and have M.S. cover. Minimum size for connector boxes is 6" x 4" and for Draw-in-Boxes 4" x 4" where steel conduits as used and it shall be M S or PVC with bakelite cover (3 mm thick) with PVC conduits wherever specified.

4.0 FAN HOOK BOXES

These shall be 100 mm (4") dia x 75 mm (3") deep, constructed from 16 SWG M.S. sheet, and provided with one 12 mm dia M.S. rod 300 mm (12" long).

5.0 PAINTING

Outside of wall switch boards, connector boxes & draw-in-boxes and other C.I./M.S. accessories shall be painted with two coats of anti-rust paint in addition to other painting instruction given elsewhere.

TECHNICAL SPECIFICATION FOR CABLE INSTALLATIONS

1.0 GENERAL

All HV Cables (upto 33 KV earthed system) shall be either paper insulated SL type or XLPE insulated aluminium conductor cable conforming to I.S. 692 and I.S. 7098 respectively.

All Medium Voltage and Low Voltage PVC insulated and armoured/unarmoured cables shall conform to IS 1554 Part-I-1964 and of 1,100 volt grade.

Old and used cables must not be used for installation. Only one make of cable shall be used. All cables brought to site must be tested and got approved by the Engineer-in-Charge before these can be laid. The cables shall be despatched to site on wooden drums with ends sealed. Exact lengths shall be determined by the Contractor after measurement at site.

The underground installation of cables shall be generally conforming to I.S. 1255-1967, Code of Practice for installation and maintenance of underground cables (upto including 33 KV).

2.0 LAYING OF CABLES

a) Direct in Ground : Trenches shall be 750 mm deep (minimum) for LT Cables and 1.2 M (4'-0") deep minimum) for HT Cables from ground level and trenching work shall include all pumping and bailing out water. These trenches shall be wide enough to accommodate all the cables with brick separations as per the requirements specified in the relevant I.S.

When more than one multicore cable is to be laid in the same trench, a minimum horizontal interaxial spacing between cables will be as per relevant I.S.

After excavation of the trench of proper size, the bottom of the trench shall be dressed and levelled and filled with a 75 mm layer of fine sand. The cable shall then be laid with bricks on both sides of the cable continuously. After having the space within the bricks, filled and packed upto a level of 75 mm (3") above top of cable with fine sand, the top layer of bricks shall be placed side by side in continuous series as protective cover. Total No. of bricks required being 16 per metre run. The remainder of the trench shall be filled with riddled soil, well rammed and watered to a level of 75 mm (3") above surrounding ground level. The ground level surface of the whole trench route shall be restored properly after completion of cable laying.

b) Inside Building: Cables shall be laid on walls/ceiling/structure, unless specified otherwise, with M.S. brackets and suitable clamps or over claw type aluminium cleats fixed on M.S. brackets, spaced not more than 450 mm apart. G.I Bolts of suitable sizes are to be grouted on the wall properly for fixing the brackets.

Minimum bending radius permissible is 12D for MV Cables and 20D for HV cables. At joints and terminations, the individual core of multicore cables should never be bent so that the radius is less than 15 times the diameter over the insulation. No cable jointing is allowed between two terminal points.

3.0 CABLE JOINTING

All cable joints shall be carried out by experienced and Licenced jointers under strict supervision. Electro plated brass cable glands, aluminium/tinned copper cable sockets and approved jointing materials must be used. The price for cable jointing and finishing the ends of the cable shall include all materials and shall also provide for tools and plants for the work. The cable armouring is to be properly terminated. All cable accessories and other associated materials shall conform to Indian Standard Specification where applicable. Proper earthing of cable glands and armouring shall be included in the job.

4.0 TESTING OF CABLES : All cables shall be tested for insulation resistance with megger - 5,000V constant pressure megger insulation tester for HT Cables and 1,000 V constant pressure megger for MV Cables, before installation.

After installation and end termination, the cables shall be again subjected to the above test. Insulation value for HT Cables shall not be less than 100 megohms and for MV Cables 1.0 megohm.

After laying and jointing, the HV Cables shall be subjected to high voltage pressure test before commissioning, the test voltage being as specified in I.S.1255-1967 or latest.

5.0 TESTING OF INSTALLATION

Before the completed installation is put into service or handed over to Owner, the installation is to be subjected to the above tests to the satisfaction of the Engineer-in-Charge. The completed work will be taken over only if the results are acceptable to the Architects/Owner.

TECHNICAL SPECIFICATION FOR EARTHING INSTALLATION

The installation shall generally conform to IS 3043 - Indian Standard Code of Practice for Earthing, as amended upto date.

1.0 EARTHING

a) Plate Electrode

Where plate electrode for earthing is to be employed, the size of the plate shall not be less than 0.6 m x 0.6 m x 6.3 mm thickness for G.I plate and 0.6 m x 0.6 m x 3.15 mm thickness in case of copper plate.

The plate shall be buried vertically with the top at a minimum of 4.0 M below the ground level for sandy soil and 2.0 M below the ground level for normal soil. In order to place the same at the prescribed depth, the dimension of pit to be excavated shall be 0.9 m x 0.9 m x 3 M deep. The plate shall be placed in position by the contractor only after the inspection of excavated pit and approval is obtained from the Architect/Engineer.

One no. 50 mm x 6 mm G.I flat (for electrical installation) or one no. 25 mm x 6 mm GI flat (for Lighting conductor)

should be connected to the plate at two points by means of 65 mm long 12 mm dia galv bolts, nuts and galv washers. In case of copper plate copper flat of not less than 32 mm x 6.0 mm shall be used as the earth lead. Brass bolts, nuts and washers shall be used for fixing. All other details shall be in accordance with IS 3043-1987. No joint on the earth lead conductor is permitted. Every care be taken to ensure that the ends of the wire/flats have been securely clamped by the bolt on cleaned surface of the plate and established a good electrical contact.

After placing the plate the earth lead conductor shall be protected by means of a continuous length of G.I pipe (Class-B) having 50 mm dia bore or depending upon the size of the lead, right from the plate upto a height of 0.60 metre (2 ft) above ground level. The whole length of pipe shall be filled with bituminous compound of approved make and brand. The molten compound shall be poured from the top end the pipe and topped upto overflowing.

The plate electrode shall have a 50 mm galvanized iron water pipe buried vertically and adjacent to the electrode and reaching upto the center of the plate. The upper end of the pipe shall be at least 5 cm above the bottom of the inspection pit and with wire mesh, funnel, etc as per IS specification.

2.0 MASONRY INSPECTION PIT

The inspection pit for the earth station shall be approx 0.56 M x 0.56 M (1'-10"x1'-10") outside dimensions and approx 0.45 M (1'-6") deep when completed, having 5"thick cement brick work with 1st class bricks in cement mortar (6:1) both inside and outside plastered 19 mm (3/4") thick and neatly cemented 1.60 mm (1/16") thick, both inside, outside and top. The opening on top shall be provided with a C.I. ring with lockable cover fixed flush with ground surface. All the excavations shall be duly back filled, dressed and rammed.

3.0 LOCATION FOR EARTH ELECTRODES

Electrodes shall be buried at least 2 M (6'-6") away from the building pole or object to be earthed. However, earthing electrodes for L.C. installations should be as close to the down conductors as possible.

Electrodes, when installed in parallel, shall not be placed less than 2 M (6'-6") apart and preferably placed at distances greater than twice their lengths.

4.0 EARTH BUSBAR

a) Galvanised M.S. Flat : The busbar shall be of suitable size and length, as specified in the Schedule of Items, heavily galvanised and having adequate number of drilled and tapped holes 30 mm apart, complete with G.I. bolts, nuts, washers for securely connecting the earth leads and earth continuity conductors. The busbar shall be fixed on wall, having clearance of 6 mm from wall with spacing insulators with at least 13 mm (1/2") G.I. rag bolts spaced about 0.46 M (1'-6") apart.

b) Copper Flats : To be used, as specified, in the Schedule of Items, where earthing requirements are more stringent. Brass bolts, nuts washers shall be used for connections.

5.0 VALUE OF EARTH RESISTANCE

In case of installations where the load does not exceed 5 K.W. the resistance to earth shall on no account exceed 5 ohms. Where the load exceeds 5 K.W. the resistance shall not exceed 1 ohm.

CHAPTER – D

TECHNICAL SPECIFICATIONS FOR FIRE FIGHTING SYSTEM

1. FIRE FIGHTING WORKS- FIRE PROTECTIONS-GENERAL

Scope of work shall include design, engineering, supply, installation, testing & commissioning of fire fighting system. All material shall be of conforming to relevant IS specifications wherever exists and subject to approval of Engineer in charge. The fire fighting shall be carried out strictly as per NBC -2016. Testing, commissioning & getting approvals from various inspection authorities and obtaining No objection certificate (NOC) for occupation of buildings.

1.1. TENDER DRAWINGS

The contractor on award of work will furnish detailed stage-wise working drawings as required in advance for approval of Engineer. No claim whatsoever shall be admissible on account of changes that may be introduced by the Engineer.

1.2. DRAWINGS/TECHNICAL DATA SHEETS

The contractor shall prepare and furnish all drawings including floor plans & Terrace, Schematic Fire Fighting Layout/External Fire Layout showing sprinklers, Fire Hydrants/First Aid Hose, Extinguishers, Signages. Drawings shall be based on the Architectural drawings/Tender Drawings and requirements laid down in the specifications, Design Basis Report and as per site conditions. The manufacturing of equipment shall be commenced only after the shop drawings/GA Drawings/ technical data sheet along with pump curves are approved in writing by the Engineer.

1.3. COMPLETION / AS BUILT DRAWINGS

On completion of the work and before issuance of certificate of virtual completion, the contractor shall submit to the Engineer –in-Charge, General layout drawings, drawn at approved scale indicating layout of pump house piping and its accessories “As installed. As built drawings shall be prepared taking approved drawings as base & incorporating all changes/ modifications as per site conditions.

1.4. DRAWINGS & DOCUMENTS

The contractor shall submit to the Engineer, the following documents on completion of the work and before issuance of virtual completion.

- a. Warranty for required equipment installed like Panels etc.
- b. As Built Drawings
- c. Material Test Certificates
- d. Catalogues/Brochures
- e. Operation and Maintenance Manuals
- f. List of recommended spares and consumables
- g. All approvals including technical approvals and sanctions

1.5. MANUFACTURING

The responsibility for ensuring the manufacture of the equipment as per the specifications shall be solely that of the contractor. The contractor shall be responsible for selection of materials as per agreed specifications.

1.6. MAKE OF MATERIALS/MANUFACTURER'S INSTRUCTION

Only approved makes as mentioned in our approved make list of tender documents of material shall be used. The Contractor shall furnish Technical data sheets / GA drawings of all items before placing P.O. The contractor shall get the samples of required items approved from the Authority Engineer/Engineer-in-Charge.

1.7. MATERIAL TESTING

The E-I-C shall have full power to get any material of work to be tested by an independent agency at contractor's expense in order to prove the soundness and adequacy.

1.8. INSPECTION AND TESTING

- a. All equipment shall be inspected and tested as per an agreed Quality Assurance Plan before the same is packed and dispatched from the contractor's works. The contractor shall carry out tests as specified/ directed by engineer.
- b. The E-I-C may, at his sole discretion, carry out inspection at different stages during manufacturing and final testing after manufacturing.
- c. Approvals or passing of any inspection by the engineer or his authorized representative shall not, however, prejudice the right of the engineer to reject the plan if it does not comply with the specification when erected or give complete satisfaction in service.

1.9. TRAINING OF DEPARTMENT PERSONNEL

- a. The contractor shall train the OFAJ's personnel to become proficient in operating the equipment installed. Training shall be done before the expiry of the defects liability period.
- b. The period of training shall be adequate and mutually agreed upon by the Engineer and contractor.
- c. Nothing extra shall be paid to the contractor for training OFAJ personnel.

1.10. PERFORMANCE GUARANTEE

At the close of the work and before issue of final certificate of completion by the engineer, the contractor shall furnish written guarantee indemnifying the OFAJ against defective materials and workmanship for a period of one year after completion and handing over. The contractor shall hold himself fully responsible for reinstallation or replace free of cost to the OFAJ.

- a. Any defective material or equipment supplied by the contractor.

2. ELECTRIC DRIVE, HORIZONTAL FIRE PUMPS

Without restricting to the generality of the foregoing, the pumps and ancillary and accessories.

- i. Electrically operated pumps with motors, base plates and accessories.
- ii. Alarm system with all accessories wiring and connections.
- iii. Pressure gauges with isolation valves and piping bleed and block valves.
- iv. M.S. pipes, valves, suction strainers, delivery headers and accessories.
- v. Foundations, vibration eliminator pads and foundation bolts.

2.1. QUALITY CONTROL

These shall comply with the IS codes as specified.

2.2. SUBMISSIONS

- a. Product Manuals
- b. Hydraulic Details

2.3. STORAGE

These shall be stored as delivered in original packing.

case may be. An audio-visual alarm shall be given at the Control Panel.

CHAPTER – E

TECHNICAL SPECIFICATIONS FOR FIRE ALARM SYSTEM

1.

FIRE ALARM SYSTEM

GENERAL

- a. The specifications includes furnishing, installation, connection and testing of the microprocessor controlled, intelligent reporting fire alarm network equipment required to form a complete, operative, coordinated system.
- b. The fire alarm system shall comply with requirements of IS:2189:1999& 1996 NFPA Standard 72 for Protected Premises Signalling Systems except as modified and supplemented by this specification, or the stringent one of the two specification in case of any discrepancy. The system shall be electrically supervised and monitor the integrity of all conductors.
- c. Fire Alarm System shall be integrated with P.A. system. A digitized pre-recorded voice message shall notify occupants that a fire condition has been reported.
- d. The system and its components shall be Underwriters Laboratories, Inc. listed under the appropriate UL testing standard as listed herein for fire alarm applications and shall be in compliance with the UL listing for equivalent European standard EN54.
- e. Each designated zone shall transmit separate and different alarm, supervisory and trouble signals to the Fire Alarm Control Room and designated personnel.
- f. The FACP's shall be active/interrogative-type systems where each transponder is repetitively scanned, causing a signal to be transmitted to the fire alarm control panel node indicating that the transponder and its associated initiating device and notification appliance circuit wiring is functional. Loss of this signal at the FACP shall result in a trouble indication on both the FACP display and at the network display, as specified hereinafter for the particular input.
- g. The system shall be arranged such that not less than 20 percent additional transponders may be inserted into any network communication loop.
- h. The installing company shall employ technicians on site to guide the labours and to ensure the systems integrity.

1.1.

SCOPE:

- a. A new network intelligent reporting, microprocessor controlled fire detection and shall be compatible with PA system emergency voice alarm communication network shall be installed in accordance with the specifications and drawings.

b. Basic Performance:

- i. Alarm and trouble signals from the FACP, NRT, and NLCD network nodes shall be digitally encoded by listed electronic devices onto a NFPA Style 9 looped multiplex communication system.
- ii. Alarm, trouble and supervisory signals from all intelligent reporting devices shall be encoded onto NFPA Style 6 (Class A) Signalling Line Circuits (SLC).
- iii. Initiation Device Circuits (IDC) shall be wired Class A (NFPA Style D). Connected by the SLC.
- iv. Notification Appliance Circuits (NAC) shall be wired Class A (NFPA Style Z) connected by the SLC.

- v. Power for initiating devices and notification appliances must be from the main fire alarm control panel, the transponder to which they are connected or to a Field Charging Power Supply (FCPS).
- vi. A single ground or open on any system signalling line circuit, initiating device circuit, or notification appliance circuit shall not cause system malfunction, loss of operating power or the ability to report an alarm.
- vii. Alarm signals arriving at the main FACP shall not be lost following a power failure (or outage) until the alarm signal is processed and recorded.
- viii. Digitized electronic signals shall employ check digits or multiple polling.
- ix. Transponder devices are to consist of low current, solid-state integrated circuits, and shall be powered locally from a primary power and standby power source.
- x. F.A. System shall be integrated with P.A system & Car Calling system so that it can be used for Emergency evacuation under fire condition.

1.2.

SUBMITTALS

A. General:

All substitute equipment proposed as equal to the equipment specified herein, shall meet or exceed the following standards. For equipment other than that specified, the contractor shall supply proof that such substitute equipment does in fact equal or exceed the features, functions, performance, and quality of the specified equipment. Two copies of all submittals shall be submitted to the Engineer-in-charge/Engineer for review.

B. Shop Drawings:

1. Sufficient information, clearly presented, shall be included to determine compliance with drawings and specifications.
2. Include manufacturer's name(s), model numbers, ratings, power requirements, equipment layout, device arrangement, complete wiring point-to-point diagrams, and conduit layouts.
3. Show equipment layout and main control panel, module layout, configurations and terminations.

C. Manuals:

Submit simultaneously with the shop drawings, complete operating and maintenance manuals listing the manufacturer's name(s) including technical data sheets. Wiring diagrams shall indicate internal wiring for each item of equipment and the interconnections between the items of equipment. Provide a clear and concise description of operation, which gives the information required to properly operate the equipment and system. Approvals will be based on complete submissions of manuals together with shop drawings.

D. Software Modifications

Provide the services of a factory trained and authorized technician to perform all system software modifications, upgrades or changes. Response time of the technician to the site shall not exceed 2 hours. Provide all hardware, software, programming tools and documentation necessary to modify the fire alarm network on site.

E. Certifications:

Together with the shop drawing submittal, submit a certification from the major equipment manufacturer indicating that the proposed supervisor of installation and the proposed performer of contract maintenance is an authorized representative of the major equipment manufacturer and trained on network applications. Include names and addresses in the certification.

1.3. APPLICABLE PUBLICATIONS:

The publications listed below form a part of this specification. The publications are referenced in text by the basic designation only.

A. The fire alarm system shall comply with requirements of NFPA 72 for protected premises signalling systems except as modified and supplemented by this specification. The system field wiring shall be supervised either electrically or by software-directed polling of field devices.

B. Underwriters Laboratories Inc. (UL) - USA: / EN - 54

C. NBC - 2016 (Part-4)

1.4. APPROVALS/ GOVERNING SPECIFICATIONS:

A. Detectors/ Devices:

(a) Heat Detectors shall conform to IS-2175 - 1988 or BS-5445 (EN 54) Part 5-

1977 (VdS/LPCB approved) or NFPA72 (UL/ULC/FM approved) amended up to date.

(b) Smoke Detectors shall conform to IS-11360-1985 or BS 5446 Part I-1977 & Part VII - 1985 (VdS/LPCB approved) or NFPA72 (UL/ULC/FM approved) amended up to date.

(c) For other detectors/devices relevant IS or BS (EN 54) (VdS/LPCB approved) or NFPA 72 (UL/ULC/FM approved) amended up to date.

1.5. EQUIPMENT AND MATERIAL:

1.5.1. GENERAL

A. All equipment and components shall be new, and the manufacturer's current model.

The materials, appliances, equipment and devices shall be tested and listed by a nationally recognized approvals agency for use as part of a protected premises protective signalling (fire alarm) system. The authorized representative of the manufacturer of the major equipment, such as control panels, shall be responsible for the satisfactory installation of the complete system.

B. All equipment and components shall be installed in strict compliance with each manufacturer's recommendations. Consult the manufacturer's installation manuals for all wiring diagrams, schematics, physical equipment sizes, etc. before beginning system installation. Refer to the riser/connection diagram for all specific system installation/termination/wiring data.

C. All equipment shall be attached to walls and ceiling/floor assemblies and shall be held firmly in place. (e.g., detectors shall not be supported solely by suspended ceilings). Fasteners and supports shall be adequate to support the required load.

1.5.2. WIRE& Cable

Fire Survival Cable: For the detector and sounders proposed to fixed on false ceiling/surface, the wiring shall be done with Fire Survival Cable capable of withstanding temperature up to 950 degree C for 20 minutes and 650 degree C for the 180 minutes. The fire survival cable shall be laid on surface with proper saddle etc. as per requirement & in cable tray above false ceiling. The cables may be armoured/unarmoured as per the location of use.

1.6. FIRE ALARM CONTROL PANELS AND FIRE CONTROL ROOM:

The Fire Alarm Control Panel shall be as per IS: 2189 (latest amended). Each network FACP shall contain a microprocessor-based central processing unit (CPU). The CPU shall communicate with and control the following types of equipment used to make up the system: intelligent addressable detectors, addressable modules, Panel modules including initiating circuit, control circuits, transponders, local and remote operator terminals, printers, annunciators, emergency voice communication systems, and other system controlled devices.

Each FACP on the network shall perform the following functions:

1. It shall Supervise and monitor all intelligent addressable detectors and monitor modules connected to the system for normal, trouble and alarm conditions.

2. It shall supervise all initiating signalling and notification circuits throughout the facility by way of connection to monitor and control modules.

3. It shall detect the activation of any initiating device and the location of the alarm condition. Operate all notification appliances and auxiliary devices as programmed. In the event of CPU failure, all SLC loop modules shall fall back to degrade mode. Such degrade mode shall treat the corresponding SLC loop control modules and

associated detection as conventional two-wire operation. Any activation of a detector in this mode shall automatically activate associated Notification Appliance Circuits.

4. It shall visually and audibly annunciate any trouble, supervisory, security or alarm condition on operator's terminals, panel display, and annunciators.

5. When any of the following condition is detected and reported by one of the system initiating devices or appliances:

- i. Fire Alarm Conduits
- ii. Trouble Confirmation
- iii. Supervisory Card
- iv. Security Alarm
- v. Pre Alarm

Then the following functions shall immediately occur:

- a. The FACP alarm LED on the FACP shall flash.
- b. A local piezo-electric indication for the event signal for the event in the FACP shall sound a distinctive Signal.
- c. Printing and history storage equipment shall log the information associated with the fire alarm control panel condition, along with the time and date of occurrence.
- d. All system output programs assigned via control-by-event interlock programming to be activated by the particular point in alarm shall be executed, and the associated system outputs (alarm notification appliances and/or relays) shall be activated on either local outputs or points located on other network nodes.

General FACP Configuration & Operation

- a. Each FACP node shall include a full featured operator interface control and annunciation panel which shall include a backlit Liquid Crystal Display (LCD), individual, colour coded system status LEDs, and an alpha-numeric keypad for field programming and control of the node.
- b. All programming or editing of the existing programming in the system shall be achieved without special equipment or interrupting the alarm monitoring functions of the fire alarm control panel.
- c. FACP nodes shall be designed so that it permits continued local operation of remote transponders under both normal and abnormal network communication loop conditions. This shall be obtained by having transponders operate as local control panels upon loss of network communication.
- d. FACP nodes shall be modular in construction to allow ease of servicing. Each CPU and transponder shall be capable of being programmed on site without requiring the use of any external programming equipment. Systems which require use of external programmers or change of EPROMs are not acceptable.
- e. The CPU and associated equipment are to be protected so that they will not be affected by voltage surges or line transients including RFI and EMI.
- f. Each transponder and peripheral device connected to the FACP node CPU shall be continuously scanned for proper operation. Data transmissions between network nodes, FACP, CPUs, transponders, and peripheral devices shall be reliable and error free. The transmission scheme used shall employ dual transmission or other equivalent error checking techniques. Failure of any transponder or peripheral device to respond to an interrogation shall be annunciated as a trouble condition.

The FACP shall be able to provide the following software and hardware features:

1. Pre- Signal and Positive Alarm Sequence: The system shall provide means to cause pre-alarm signals to only sound in specific areas with a delay of the alarm from 60 to up to 180 seconds after start of alarm processing. In addition, a Positive Alarm Sequence selection shall be available that allows a 15-Second time period for acknowledge an alarm signal from a fire detection/initiating device. If the alarm is not acknowledged within 15 seconds, all local remote outputs shall automatically immediately.

2. Smoke Detector Pre-Alarm indication at control panel: To obtain early warning of incipient or potential fire conditions, the system shall support a programmable option to determine system response to real-time detector sensing values above the programmed setting. Two levels of Pre-Alarm indication shall be available at the control.

i) Alert: It shall be possible to set individual smoke detectors for pre-programmed pre-alarm thresholds. If the individual threshold is reached, the pre-alarm condition shall be activated.

ii) Action: if programmed for action and the detector reaches a level exceeding the pre programmed level, the control panel shall indicate an action condition, Sounder bases installed with either heart or smoke detectors shall automatically activate on action Pre Alarm level, with general evacuation on alarm level.

3. The system shall be integrated with P.A. system for Emergency evacuation under fire.

4. Each FACP node shall be capable of providing the following features:

a) Block Acknowledge for Trouble Conditions, b) Rate Charger Control, c) Control-By-Time (Delay, Pulse, time of day, etc.), d) Automatic Day/Night Sensitivity Adjust (high/low), e) Device Blink Control (turn of detector LED strobe), f) Environmental Drift Compensation (selectable ON or OFF), g) Smoke Detector Pre-alarm Indication at Control Panel, h) NFPA 72 Smoke Detector Sensitivity Test, i) System Status Reports, j) Alarm Verification, by device, with tally, k) Multiple Printer Interface, l) Multiple CRT Display Interface, m) Non-Fire Alarm Module Reporting, n) Automatic NFPA 72 Detector Test, o) Programmable Trouble Reminder, p) Upload/Download System Database to BMS, q) One-Man Walk Test, r) Smoke Detector Maintenance Alert, s) Security Monitor Points, t) Alpha-numeric Pager Interface, u) On-line or Off-line programming

Network Repeater Panel (NRP)

- A network control annunciator shall be provided to display all system intelligent points. The NRP shall be capable of displaying all information for all possible points on the network.

- Network display devices which are only capable of displaying a subset of network points shall not be suitable substitutes.

- The network control annunciator shall have the ability to display up to eight events in order of priority and time of occurrence. Counters shall be provided to indicate the total number of events by type.

- The NRP shall mount in any of the network node fire alarm control panels. Optionally, the network display may mount in a back box designed for this use.

1.7. Water flow Indicators:

Water flow Switches shall be an integral, mechanical, non-coded, non-accumulative retard type. Water flow Switches shall have an alarm transmission delay time, which is conveniently adjustable from 0 to 60 seconds. Initial settings shall be 30-45 seconds. All water flow switches shall come from a single manufacturer and series. Water flow switches shall be provided and connected under this section but installed by the mechanical contractor. Where possible, locate water flow switches a minimum of one (1) foot from a fitting, which changes the direction of the flow and a minimum of three (3) feet from a valve.

1.8. Sprinkler and Standpipe Valve Supervisory Switches:

Each sprinkler system water supply control valve riser, zone control valve, and standpipe system riser control valve shall be equipped with a supervisory switch. Standpipe hose valves, and test and drain valves shall not be equipped with supervisory switches. PIV (post indicator valve) or main gate valves shall be equipped with a supervisory switch. The switch shall be mounted so as not to interfere with the normal operation of the valve and adjusted to operate within two revolutions toward the closed position of the valve control, or when the stem has moved no more than one-fifth of the distance from its normal position. The supervisory switch shall be contained in a weather proof Aluminium housing, which shall provide a 25 mm conduit entrance and incorporate the necessary facilities for attachment to the valves. The switch housing shall be finished in red baked enamel. The entire installed assembly shall be tamper proof and arranged to cause a switch operation if the housing cover is removed, or if the unit is removed from its mounting. Valve supervisory switches shall be provided and connected under this section and installed by mechanical contractor.

1.9. Non-Alarm Input Operation

Any addressable initiating device in the system may be used as a non-alarm input to monitor normally open contact type devices. Non-alarm functions are a lower priority than fire alarm initiating devices.

1.10. SYSTEM COMPONENTS - ADDRESSABLE DEVICES

1.10.1. DETECTORS& ADDRESSABLE DEVICES

The addressable detector and devices shall comply to the below mentioned specifications.

The addressing of detectors and devices shall be of rotary type electronic addressing shall not be acceptable.

I. Intelligent Laser Photo Smoke Detector

a) The intelligent laser photo smoke detector shall be a spot type detector that incorporates an extremely bright laser diode and an integral lens that focuses the light beam to a very small volume near a receiving photo sensor. The scattering of smoke particles shall activate the photo sensor.

b) The laser detector shall have conductive plastic so that dust accumulation is reduced significantly.

c) The intelligent laser photo detector shall have nine sensitivity levels and be sensitive to a minimum obscuration of 0.03 percent per foot.

d) The laser detector shall not require expensive conduit, special fittings or PVC pipe.

e) The intelligent laser photo detector shall support standard, relay, isolator and sounder detector bases.

f) The laser photo detector shall not require other cleaning requirements than those listed in NFPA 72. Replacement, refurbishment or specialized cleaning of the detector head shall not be required.

g) The laser photo detector shall include two bi-color LEDs that flash green in normal operation and turn on steady red in alarm.

II. Intelligent Multi Criteria Acclimating Detector

a) The intelligent multi criteria Acclimate detector shall be an addressable device that is designed to monitor a minimum of photoelectric and thermal technologies in a single sensing device. The design shall include the ability to adapt to its environment by utilizing a built-in microprocessor to determine its environment and choose the appropriate sensing settings. The detector design shall allow a wide sensitivity window, no less than 1 to 4% per foot obscuration. This detector shall utilize advanced electronics that react to slow smouldering fires and thermal properties all within a single sensing device.

b) The microprocessor design shall be capable of selecting the appropriate sensitivity levels based on the environment type it is in (office, manufacturing etc.) and then have the ability to automatically change the setting as the environment changes (as walls are moved or as the occupancy changes).

c) The intelligent multi criteria detection device shall include the ability to combine the signal of the thermal sensor with the signal of the photoelectric signal in an effort to react hastily in the event of a fire situation. It shall also include the inherent ability to distinguish between a fire condition and a false alarm condition by examining the characteristics of the thermal and smoke sensing chambers and comparing them to a database of actual fire and deceptive phenomena.

III. Intelligent Thermal Detectors

Thermal detectors shall be intelligent addressable devices rated at 135 degrees Fahrenheit (58 degrees Celsius) and have a rate-of-rise element rated at 15 degrees F (9.4 degrees C) per minute. It shall connect via two wires to the fire alarm control panel signalling line circuit.

IV. Intelligent Photoelectric Smoke Detector

The detectors shall use the photoelectric (light-scattering) principal to measure smoke density and shall, on command from the control panel, send data to the panel representing the analogue level of smoke density.

V. Intelligent Multi Sensor Intelliquad Detector (CO, IR, Smoke & Heat)

a) The intelligent multi sensor Intelliquad detector shall be an addressable device that is designed to monitor a minimum of photoelectric, thermal technologies, carbon monoxide & infrared in a single sensing device. The design shall include the ability to adapt to its environment by utilizing a built-in microprocessor to determine it's environment and choose the appropriate sensing settings. The detector design shall allow a wide sensitivity

window, no less than 1 to 4% per foot obscuration. This detector shall utilize advanced electronics that react to slow smouldering fires and thermal properties all within a single sensing device.

b) The microprocessor design shall be capable of selecting the appropriate sensitivity levels based on the environment type it is in (office, manufacturing, parking etc.) and then have the ability to automatically change the setting as the environment changes (as walls are moved or as the occupancy changes).

c) The intelligent multi sensor detection device shall include the ability to combine the all of four signals in an effort to react hastily in the event of a fire situation. It shall also include the inherent ability to distinguish between a fire condition and a false alarm condition by examining the characteristics of the thermal and smoke sensing chambers and comparing them to a database of actual fire and deceptive phenomena.

VI. Intelligent Duct Smoke Detector

a) The smoke detector housing shall accommodate either an intelligent ionization detector or an intelligent photoelectric detector, of that provides continuous analogue monitoring and alarm verification from the panel.

b) When sufficient smoke is sensed, an alarm signal is initiated at the FACP, and appropriate action taken to change over air handling systems to help prevent the rapid distribution of toxic smoke and fire gases throughout the areas served by the duct system.

c) Isolator modules shall be provided to automatically isolate wire-to-wire short circuits on an SLC Class A or Class B branch. The isolator module shall limit the number of modules or detectors that may be rendered inoperative by a short circuit fault on the SLC loop segment or branch. At least one isolator module shall be provided for each floor or protected zone of the building.

d) If a wire-to-wire short occurs, the isolator module shall automatically open-circuit (disconnect) the SLC. When the short circuit condition is corrected, the isolator module shall automatically reconnect the isolated section.

e) The isolator module shall not require address-setting, and its operations shall be totally automatic. It shall not be necessary to replace or reset an isolator module after its normal operation.

f) The isolator module shall provide a single LED that shall flash to indicate that the isolator is operational and shall illuminate steadily to indicate that a short circuit condition has been detected and isolated.

g) The isolator module shall not consume any detector or device address from the loop capacity.

VII. Addressable Control Relay Module

The relay shall be form C and rated for a minimum of 2.0 Amps resistive or 1.0 Amps inductive. The relay coil shall be magnetically latched to reduce wiring connection requirements, and to insure that 100% of all auxiliary relay or NACs may be energized at the same time on the same pair of wires.

VIII. Addressable Control Module

a) Addressable control modules shall be provided to supervise and control the operation of one conventional NACs of compatible, 24 VDC powered polarized audio/visual notification appliances.

b) The control module NAC may be wired for Style Z or Style Y (Class A/B) with up to 1 amp of inductive A/V signal, or 2 amps of resistive A/V signal operation.

c) Audio/visual power shall be provided by a separate supervised power circuit from the main fire alarm control panel or from a supervised UL listed remote power supply.

d) The control module shall be suitable for pilot duty applications and rated for a minimum of 0.6 amps at 30 VDC.

IX. Manual Pull Stations

The fire alarm station shall be of polycarbonate construction and incorporate an internal toggle switch. A locked test feature shall be provided. The station shall be finished in red with silver "PULL IN CASE OF FIRE" lettering.

X. Programmable Electronic Exit Point Sounders With Strobe Light

- a) Shall follow NFPA 72 2007 edition recommendation.
- b) Electronic sounders shall operate on 24 VDC nominal.
- c) Electronic sounders shall be field programmable without the use of special tools, at a sound level of at least 90 dBA measured at 10 feet from the device.
- d) Shall be capable to broadcast pre-programmed Voice Message also
- e) Shall be flush or surface mounted as shown on plans.
- f) Shall produce broad band directional sound with 20 Hz to 20 KHz frequency band to guide occupants to safe exists even in complete darkness.
- g) Strobe lights shall meet the requirements of the ADA, UL Standard 1971, be fully synchronized, and shall meet the following criteria:
 - h) The maximum pulse duration shall be 2/10 of one second.
 - i) Strobe intensity shall meet the requirements of UL 1971.
 - j) The flash rate shall meet the requirements of UL 1971.
- k) Field Wiring Terminal Blocks
- l) For ease of service all panel I/O wiring terminal blocks shall be removable, plug in types and have sufficient capacity for #18 to #12 AWG wire. Terminal blocks that are permanently fixed are not acceptable.

1.11. TEST

The service of a competent, factory-trained engineer or technician authorized by the manufacturer of the fire alarm equipment shall be provided to technically supervise and participate during all of the adjustments and tests for the system.

- a. Before energizing the cables and wires, check for correct connections and test for short circuits, ground faults, continuity, and insulation.
- b. Close each sprinkler system flow valve and verify proper supervisory alarm at the FACP.
- c. Verify activation of all flow switches.
- d. Open initiating device circuits and verify that the trouble signal actuates.
- e. Open signalling line circuits and verify that the trouble signal actuates.
- f. Open and short notification appliance circuits and verify that trouble signal actuates.
- g. Open and short (wire only) network communications and verify that trouble signals are received at network annunciators or reporting terminals.
- h. Ground initiating device circuits and verify response of trouble signals.
- i. Ground signalling line circuits and verify response of trouble signals.
- j. Ground notification appliance circuits and verifies response of trouble signals.
- k. Check alert tone and pre-recorded voice message to all alarm notification devices.
- l. Check installation, supervision & operation of all intelligent smoke detectors using walk test.
- m. Each of the alarm conditions that the system is required to detect should be introduced on the system. Verify the proper receipt and the proper processing of the signal at the FACP and the correct activation of the control points.

n. When the system is equipped with optional features, the manufacturer's manual should be consulted to determine the proper testing procedures. This is intended to address such items as verifying controls performed by individually addressed or grouped devices, sensitivity monitoring, verification functionality and similar.

1.12. FINAL INSPECTION:

At the final inspection, a factory-trained representative of the manufacturer of the major equipment shall demonstrate that the system functions properly in every respect.

1.13. INSTRUCTION & SEQUENCE OF OPERATION:

Instruction shall be required for operating the system. Hands-on demonstrations of the operation of all system components and the entire system including program changes and functions shall be provided. The contractor and/or the systems manufacturer's representatives shall provide a typed written "Sequence of Operation."

NOTE: Fire alarm system shall comply to NBC 2016. Anything mentioned above, if not required as per NBC 2016 may be omitted.

List of Approved Makes

A. CIVIL WORKS

Sl. No.	Details of Equipment/Material	Makes/Manufacturers
1	Adhesive for Ceramic tiles/ Stone/ Stone Sealers	Roff (Pidilite) / Weber (Saint Gobain)/ Sika/ Sealix/ BASF
2	Adhesive for Wood Work	3M/Pidilite/Basf/ Zerodrip /Fosroc/ Mapei
3	Adhesive Tape	3M/ Norton/Ceilux/Appolo industries
4	Aluminium Door & Window System	Windfall/ Fenesta/ Encraft/ Aluplast / Hindalco
5	Aluminium Accessories and Hardware	Windfall/ Fenesta/ Encraft/ Aluplast
6	Aluminium Glass Facade	Saint Gobain/ RAC Extrusion / Hunter Douglas/ Schuco
7	Aluminium Composite Panels	Eurobond / Viva / Alstrong / Alstone / Reynobond
8	Aluminium Die-Cast handles & two point locking kit	Dorma/Saint Gobain/ Windfall / Hunter Douglas/ Schuco
9	Aluminium Extrusion/ Sections	Hindalco / Jindal/ Bhoruka / Nalco
10	Anchor Fastner/Dash Fastner	Hilti / Fischer /Bosch/ Mapei
11	Anti - Termite Treatment	It should be done by permanent members of IPCA as approved by Engineer-in-Charge
12	APP Polymeric Polyethylene Felt	BITUMAT/ STP/ Bengal Bitumen
13	Backer rod	Supreme Industry/ SYSTRANS Polymers/ Backer Rod Mfg. Inc
14	Batch Mix Concrete (BMC) / Ready Mix Concrete (RMC)	The contractor to install his own computerized batching plant of suitable capacity and arrange for Transit Mixers, pumps etc. as per approval of Engineer – In- Charge. OR The RMC shall be procured from the source as approved by Engineer- In- Charge. RMC producing plants of the main Cement producers shall be preferred.
15	Bitumen	Indian Oil, Hindustan Petroleum, Bharat Petroleum etc.
16	Cement	ACC / Ultra tech / JK Cement / Ambuja / Shree/ Dalmia
17	White Cement	Birla White / JK / Ultratech/ Sealix/ ACC
18	Cement bonded particle board	Century/ Greemlam/ Duro / Bison Panel
19	Clean Room Wall Panels with/ without return air risers, Doors/ windows etc.	CLESTRA/ NICOMAC / HEMAIR / GMP / E-PACK Saint Gobain/ Hunter/Douglus/ Schuco
20	Concrete Additive/ Admixture	Pidilite / Fosroc / STP Ltd / Cera Chem/ Basf/ Zerodrip
21	Cover /Spacer Block	Fosroc / Astron/ KK
22	Curtain Rod/ Drapery Rod/ Venetian Blinds/ Blinds	Decorex/Coopers/ Meta Door/ Window Tech
23	Curing Compound	Pidilite / Fosroc / Sika/ STP Ltd./ Zerodrip / Mapei / BASF
25	Crash Guard/ Corner Guard	Great Effects/ Window Tech / JDB Healthcare / Decorex

24	Coupler (mechanical)	Dextron/ Sanfield/ Usha Martin/ G- Tech Splicing/ Ascon/ Halfen/Svaas infra max /SNTTP Rebar
25	Carpet Flooring & Skirting (Flotex)	Krone/ Milliken/ Standard Carpet/ EGE/SUMINOE
26	Compressed Chequered tiles	Somany / Kajaria /Nitco / Orient/ Johnson & Johnson
27	Door closer / Floor spring	Godrej/ Dorma/ Hafele/ Kalos
28	Door Locks & Latches	Godrej / Dorma/Hafele/ Hettich / Kalos
29	Door Seal	Anand Reddiplex/ Enviroseal / STP
30	Door (Automatic Sliding Glass Doors with complete mechanism)	Godrej/ Dorma/ Kalos/ Hafele
31	Door Shutters- Flush & Factory Hot Pressed Laminated Door Shutters	Godrej/ Dorma/ Kalos/ Hafele
32	Doors & Windows Fixtures / Fitting.	Godrej/ Hafele/ Dorma/Hormann/ Dorma/ Kalos
33	Epoxy Mortar	Fosroc/ Sika/ / BASF/ Pidilite/Dr. Fixit/ Saint Gobain/Tessella/Mapei
34	Extruded Polystyrene Board	Styrofoam by DOW Chemical's / Insuboard by Supreme Industries /STP Ltd. / Iso board ND,
35	False Ceiling - Calcium Silicate Boards & Tiles	Armstrong / Saint Gobain (Gyproc)/Aerolite/ /Knauf/ Ceilux / Hunter Douglas
36	False Ceiling – Metal	Armstrong / Hunter Douglas / Knauf/ Saint Gobain/ /Aerolite /Ceilux
37	False Ceiling - Mineral fibre	Armstrong / Knauf/ Saint Gobain / Ceilux/ Usg Boral/ Hunter Douglas
38	False Ceiling – GRG Ceiling Tiles	Saint Gobain /Armstrong/ Ceilux/ Knauf / Hunter Douglas
39	False Ceiling/ Dry wall partition system (ceiling/hanging sections)	Gyproc/ Knauf/Armstrong/ Western /DEXUNE/ Hunter Douglas/ Saint Gobain (Gyproc) /Ceilux
40	Fire Rated Doors & Frames with accessories	Shakti-Hormann /Minimax/Cease fire/Newage
41	Fire Rated Glass	Asahi India Safety Glass Ltd./ Saint Gobain/, Pyroguard/ Modi Glass
42	Fire Retardant Paint	STP / / Juton/ Soudal/ Nippon Paint/ 3M India/ Dow Corning
43	Fire Seal	Soudal/ Nippon Paint/ 3M India/ Dow Corning
44	Fire: Door Closures, Mortise Dead locks, D- Type Pull Handles, Hinges, Panic Exit Devices, Tower Bolts	Dorma/ Godrej/ Hafele/ Shakti-Hormann/Kalos
45	Fire: Sealant	3M/ Hilti / Soudal/ Nippon Paint/ Dow Corning
46	Floor Hardener	Pidilite / Sika/BASF/STP Ltd./ Fosroc/Saint Gobain/Tessella/Mapei
47	Flooring -Synthetic Acrylic (as per ITF Specifications)	Rebound/ PACE Court/Nova Cushion/ Sports Master/ Mapei
48	Glass : Float / Mirror/Toughened Glass	Modiguard / Atul / Saint Gobain/ Asahi India Safety Glass Ltd / Sisecam (HNG)/ Pilkington/ Firelite / Glaverbel
49	Glass Wool / Insulation Boards	Rockwool / UP Twiga / Lloyd Insulation/ Pidilite/ Berger/ Dexune /Rockfon/ Owens Corning/ Gyptech
50	GRC Jali	Asian GRC / Nexxstruct GRC / GRC Bangalore
51	Grout: Non-Shrink	Fosroc / Sika/ Pidilite / Mapei/BASF/ Cera Chem/ STP/Zerodrip /Fosroc
52	Grouting Compound	Pidilite/ STP/ /Cera Chem / Ultratech/ BASF/ Zerodrip /Fosroc/ Mapei/ JK Tylo / Vura / Tikidan
53	Gypsum Board / Gypsum False Ceiling/ Gypsum Partitions	Knauf / Saint Gobain (Gyproc)/ Armstrong / / Usg boral/ Ceilux/ Hunter Douglas
54	Gypsum Plaster	Ultratech/ Saint Gobain/ Asian Paints /USG

		Knauf / Sealix
55	Laminates/ Veneers	Century/Greenlam/ Duro
56	Lead Lined Door	Shakti-Hormann/ Metaflex / Tata Praves/ Supreme
57	Modular Grab bars and Disabled Hardware	Dorma / Jaquar/ Hindware/ Kohler / Hife
58	Modular SS Railing System	Metallica India / /KICH/ / Dorma/Kalos
59	Paints - Cement Based	Berger/ Nerolac/ Asian Paints/ STP Ltd./ Dulux/ Jotun / Kamdhenu
60	Paints - Epoxy paint	DULUX/ Nerolac / Berger / Asian /Pidilite/ STP Ltd./ Fosroc / Jotun/ Mapei / / Kamdhenu
61	Paints - Oil Bound Distemper / Acrylic Washable Distemper /Plastic Emulsion Paint	DULUX/ Asian Paints/ Berger / Nerolac / Jotun/ Nippon/ / Kamdhenu
62	Paints - Plastic Emulsion Paint (exterior)	Asian Paints (Apex Ultima)/ Berger (Weathercoat all Guard)/ Jotun/ Nerolac (Excel), Dr. Fixit/ DULUX / Kamdhenu
63	Paints - Synthetic Enamel Paints	DULUX (Gloss), Berger (Luxol Gold), Asian Paints (Apcolite), Jotun/ Nerolac / Kamdhenu
64	Paints - Texture paint	Berger / /Asian Paints / DULUX/STP Ltd./ Jotun / Nerolac / / Kamdhenu
65	Paint: Anti-Fungal	Sika by Liquid Plastic/ / STP Ltd./ Berger/ Cera-Chem / Kamdhenu
66	Paint-Wood Finish (Melamine & PU)	Nippon /Asian Paints / Berger / Nerolac / DULUX / / Kamdhenu
67	Putty (Wall)	JK/ Birla/ Berger/ Asian Paints/ Sealix
68	Paver blocks / Tiles (All Types)/ Grasscrete pavers	KK / Uni Stone Products (India) Pvt. Ltd/ Hindustan Tiles/ Nitco/ Pavit/ Ultra/ Duracrete/ Ntc Tiles
69	Plywood/Block board/Ply board	Greenply/ Archidply/ Century/ Kitply/ National / / Merino /
70	Polycarbonate Sheets	Greenpro/ GE Laxan- SABIC /PolyAlloy / AmeriLux International
71	Galvalume Aluminum zinc coated GI sheet /Pre- coated Puff Sheet roofing	Tata BlueScope /SAIL JYOTI/ Llyod Insulations India Ltd / S.R. Metals/ Essar/Everest /Jindal Steel / JSW Steel
72	Pre-Laminated Particle Board	Novapan /Century / Greenlam / Archidply Merino/Greenply/Everest / Kitply/ National
73	PVC continuous fillet for periphery packing	Roop / Anand / Forex Plastic/ Nagalia/ Trading Company
74	PVC Doors	Sintex/ Polyex/ Rajshri / Rushil
75	PVC Flooring	Tarkett Floors / Gerflor /Armstrong / Responsive/ Wonderfloor
76	Powder Coating Material pure Polyester	Jotun / Berger / Goodlass Nerolac/ Akzo nobel (Interpon)/Valspar/ Asian PPG
77	PVC Water Stops	Prince /Supreme/ Finolex/ /
78	RF Shielded Door	ETS Lindgern/ Synchrony Agency/ Huaming EMC India
79	Reinforcement Steel / Structural Steel	SAIL/ RINL/ TATA Steel Ltd./ Jindal Steel & Power Ltd./ JSW Steel Ltd./ ESL Steel Ltd. / Electrotherm ET TMT/JSW One TMT For Kerala Projects: Refer GoK Circular No.24/2022-Fin dtd 19.03.2022. BIS mark with IS code No. and License number (CM/L.no) is insisted in reinforcement and to be approved by Engineer-in- Charge
80	Structural Steel (Hollow Sections)	SAIL/ RINL/ TATA Steel Ltd./ Jindal Steel & Power Ltd./ JSW Steel Ltd./ Apollo Tubes / Parkash Steel
81	Restroom Cubicles	Merino/ Century/ Greenlam /Dorma/ Trespa/ Aica / Wilsonart
82	Sealant: Poly-sulphide	Pidilite / FOSROC / CICO / Sika / Dr. Fixit/ / BASF/ NIPPON PAINT / MAPEI
83	FRP Manhole Covers & Grating	Greenpro/ Everlast/ Polyalloy/ Rawji

84	SFRC / RCC Manhole Covers/ Perfect RCC Grating	KK Manholes / SK Precast Concrete/ Advent concrete vision / Daya concrete/ Dalal Tiles,/ Tokas concrete product, / Nimco precast
85	Silicon sealants /Weather Sealant / Structural Sealant	Pidilite / Fosroc//Dow Corning / Sika/ STP/ Cera-Chem/ Ferrouscrete /Soudal/ Nippon Paint/ 3M India
86	Stainless Steel	Salem Steel/ Jindal / TATA Steel/ SAIL
87	Stainless Steel bolts, Screws, Nuts & Washers	Atul/ GKW/Alloy/ Kalos/Hilti
88	Stainless Steel Clamps	Hilti / Dorma / Fischer / KALOS
89	Stainless Steel CP Grating	Chilly / Atul/Alloy/Kalos/Hilti
90	Stainless Steel D-handles	D-line /Dorma/ Hormann/ Cotswold / Schuco/ SAPA / Kalos
91	Stainless Steel Friction Stay	Schuco/ Kich/Hafele/Kalos/Godrej
92	Stainless Steel Hinges/Handles/Door Window Fixtures	Godrej/ Dorma/ Hafele/ KICH/ Hormann/ Kalos
93	Sunken Portion Treatment	Sika / BASF/ Dr. Fixit/ Endura/ Cera- Chem/ STP/ Zerodrip/Mapei
94	Super plasticizer	Pidilite / Berger/ Asian Paints/ Cera- Chem/ Dr. Fixit/ STP LTD/ Ferrouscrete koster, Fosroc, sika, Zerodrip/Mapei
95	Tiles: Glass Mosaic Tiles	Mridul/ Bizzare/ Bisazza/Opto/Musaica
96	Tiles: Glazed /Ceramic Tiles (Manufactured in own Mother Plant Only)	Kajaria / Somany/ RAK/ Johnson / Simpolo/Orient (Bell), / Tessella
97	Tiles: Heat Resistant Terrace Tiles	Johnson/ Kajaria/ Tessella/ Somany
98	Tiles: Vitrified Tiles (Double / Multi Charged)/ Germ free/Full body) (Manufactured in own Mother Plant Only)	Kajaria / Somany/ RAK/ /Johnson/ Simpolo/ Orient (Bell) / Oasis / Tessella
99	Extruded Hollow Terracotta Tile for façade	Clayton/Hunter Douglas/ Tempio/Moeding as approved by E-I-C
100	Vacuum Dewatered Flooring	Tremix / Sun Build / Avcon technics
101	Veneered Particle Board	Duro / Greenply / Century /Action Tesa
102	Water Proofing Materials	BASF/ Fosroc / Sika / STP /Pidilite/ Cera-Chem/ Mapei/ Dr. Fixit/ Ferrouscrete / Zerodrip
103	Water Proofing Compound (Crystalline)	Pidilite/ /Mapei/ / Fosroc/ Sika / Ferrouscrete /BASF/Zerodrip
104	uPVC door & window system	Fenesta, Duroplast/ Windfall/ Encraft/ Aluplast
105	uPVC Door and windows Hardwares	WINDFALL/ FENESTA/ ENCRAFT/ ALUPLAST
106	High Pressure Laminates	Greenlam/ Merino/ /Trespa / Century
107	AAC Block	Ultratech/ Ferrouscrete/Renacon/Birla Aerocon
108	AAC Block adhesive /	Ultratech/ Ferrouscrete/Renacon/ United/Fosroc,/ Sika, / Chryso/Mapei/Vura
109	Ready Mix Plaster	Ardex Endura/ Ferrouscrete/MYK Arment/ Pidilite/FOSROC/Sika/
110	Ready Mix Mortar	Ardex Endura/ Ferrouscrete/MYK Arment/ Pidilite/FOSROC/Sika/

B. PLUMBING WORK

Sl. No.	Details of material/equipment	Make/Manufacturers
1	Ball valves with floats	Plasto/Zoloto / Leader/ Audco/ honeywell /Advance / Prop
2	Butterfly valves	Zoloto/ / Audco/ Honeywell/ Kirloskar /Advance/ Prop
3	C. I Pipes & Fittings	Electrosteel/ NECO / SKF/ Kapilansh
4	Centrifugally Cast Iron Hubless Pipes & Fitting	NECO/SKF/Kapilansh/RPMF/Hepco
5	C.I Sluice Valve & Non Return Valve	Kirloskar /Leader /Zoloto/ Audco/Honeywell/ Prop / Advance
6	Brass Valves (Full way, Check and Globe Valves)	Advance/ /Audco/ L&T / Prop
7	C.I Valves (Full way, Check and Globe Valves) C.I. Manhole Covers	Leader / Kirloskar / SKF / Zoloto / NVR/ L&T NECO/B.I.C./R.I.F/HEPCO/SKF/ KAJECO/ RPMF
8	C.P. Fittings: Mixer / Bib Cock/Stop Cock/ Pillar taps/ Angle valve/ Valves Washers / Waste/ Urinal / Spreaders / Accessories etc.	Jaquar / Kohler/Grohe/Hife
9	Copper Pipe/Fittings (Capillary)	Yorkshire Imperial, U.K./ Rajco Metal Works Mumbai / IBP Conex Ltd.
10	Disc Filter	Azud, Spain/ Amaid / Arkal,
11	Drainage Pumps	KSB/ Grundfos/ Kirloskar/ Crompton/ KCJ
12	Ductile Iron Fittings (IS:9523) / Ductile Iron Pipes (IS:8329)	Electrosteel/ Kesoram/ Tisco/ Jindal/ HEPCO/ Electrotheram
13	E.P.D.M Gaskets	Anand Reddiplex / Enviro Seals / HANU
14	Forged Steel Fittings & Flanges (For Welded joints)	Rohini /Kanwal/ Vijay Cycle & Steel (VS)
15	DI-UL/FM & Flanges (For Welded joints)	Audco/ / Unique/ Vijay Cycle & Steel (VS) / Prop
16	Groove Coupling and fittings	Victaulic/ Amith cooper /Anvil
17	Hand Drier	Euronics/ Automat/ Toshi/Jaquar/ Hife
18	HDPE Pipes / Moulded Fittings	Plasto/Jain Irrigation / / Supreme/ Oriplast/ Finolex / Prop
19	HDPE Solution tank	Watcon / Ion Exchange / Water Supply Specialist Pvt. Ltd.
20	Inbuilt Drip Line	Azud/ Rainbird/ Netafim
21	MS Saddle with G.I. Riser	Harvel/Alprene/Rain Bird
22	PVC flushing cistern	Plasto/Kajaria Sanitary ware/ Somany/ Jaquar/ Hife
23	Concealed cistern	GABREIT/ Grohe/ Cera/Hife/Jaquar / Hindware
24	P.T.M.T. Fitting	Plasto/Prince India / Symet/ Prayag/ Cera

25	Pipe Fittings: G.I.	Unik/ Zoloto/ Jainsons / /Bhart Forge /
26	Pipe:- G.I.	Jindal (Hissar) / Tata / SAIL/ APL- Apollo/ Bhushan power steel /
27	Pipes & fitting: PVC for SWR Soil, Waste & Vent Pipes and fittings, Type B PVC Casing & Screen Pipes	Plasto/Prince / Supreme / Finolex/ Astral / Prop
28	Pipes & Fittings: CPVC	Plasto/Prince/ Astral / Supreme / Finolex / Prop
29	Pipes & fittings: UPVC	Plasto/Finolex / Prince / Supreme / Astral / Prop
30	Pipes & Gully Trap: Stone ware	Plasto/Perfect / S.K.F/ R.K/ Hind / Anand/ Burn
31	Pipes and Accessories: PE-AL-PE	Kitec/ Jindal/ Kissan/Vista
32	Pipes: Copper	Rajco Metal works, Mumbai / IBP Conex Ltd.
33	Pipes: M.S.	Jindal / Prakash – Surya /TATA /SAIL/ Prop Steel
34	Pipes: PP-R (PN – 16)	Amitex Polymers Pvt. Ltd./Prince/ Supreme
35	Pipes: R.C.C	Indian Hume Pipe / Pragati Concrete /Udyog Daya/ lakshmi/ / jain & co./ usha/
36	Plastic seat cover of W.C	Plasto/Jaquar /Kerovit/Duravit/ Kohler/Grohe/ Hife/ Hindware / Cera / Parryware
37	Polyethylene Storage Tank	Plasto /Sintex/ Polycon/ Supreme / Polyplast
38	PVC Floor trap	Plasto/Platinum/ Khodiyar/ Supreme/ Finolex
39	RQRC Hydrant	Harvel/Alprene/Rain Bird, USA
40	Stainless Steel Sink	Hindware / Cera/ ASIAN /Hafele/ Kalos
41	Stainless Steel Pipe & Fittings of Grade AISI 304 as per JIS Standard 3448 for Water Supply Line and Fittings	Sail (Salem Steel)/ Jindal / J-Press/ alfa Press
42	Valve Box	Rain Bird USA/Carson Brook, USA/Dura,
43	Valve: Air Release	Zoloto/Audco/Kirloskar/Advance/ Venus / Honeywell/ Drp/ Prop
44	Valve: Butterfly	Zoloto/Audco/Kirloskar/Advance/ Venus / Honeywell/ Drp/ Prop
45	Valve: Flush /Flushometer	Jaquar / Marc/ Asian/ Prop
46	Valve: Mainline Isolation	Leader /Zoloto, Kirloskar/ Audco/ Advance/ Prop
47	Valve: Pressure Relief	Leader/ Zoloto / Audco/ Honeywell/ Advance/ Prop
48	Valve: Sluice / NRV	Kirloskar/ /Zoloto/ Leader / L&T/ Audco/ Honeywell / DRP /
49	Valves: Gunmetal / C.P brass angle	Zoloto/ Leader / Audco/ Kirloskar/ Jaquar/ Drp Advance / Prop
50	VFD Pump	Crompton/ Kirloskar/ KSB/ Grundfos/ /KCJ
51	Vibration Eliminator Resisto-flex Pads & Connections	Relay Corpn./ Kanwal/ Dunlop /flexionics
52	Vitreous China Sanitary wares & White Glazed Fire Clay Sink	Jaquar /Kerovit/Duravit/ Kohler/Grohe/ Hife / Hindware / Parryware
53	Water supply pumps	KSB/ CRI/ Havells/Grundfos/ Kirloskar/ Crompton/ KCJ

C. ELECTRICAL INSTALLATION WORK

S.No.	Items	Makes
1	MS Conduit (ISI marked)with heavy duty accessories	BEC/AKG/ RM CON /Steel Kraits
2	PVC/ XLPE insulated aluminium / copper conductor armoured unarmoured MV cables upto 1100 V(ISI Marked)	Havells / Finolex/ KEI/ Polycab/Gloster
3	FRLS PVC insulated copper conductor stranded flexible wire i/c control cables(ISI Marked)	Havells/Finolex/KEI/ Polycab/Gloster
4	Cable Raceway floor/wall mounted and accessories	Legrand / MK (Honeywell) / OBO/Excel
5	Cable Tray & Accessories	Venus / MEM / BEC / RM CON/ Indeana/Excel
6	Modular Switch & Socket & Accessories	Legrand(Myrus)/Schneider (Zencelo) / legrand (Arteor)/ ABB/Anchor(Roma)
7	Metal clad Industrial Socket outlet and sheet steel Enclosure for MCCB/ MCB	Legrand/Siemens/Schneider/Hager
8	Cable Glands	Dowells/Commet/Gripwell/Raychem
9	Lugs and end termination	Dowells/Commet/Braco
10	Change over switch	L&T / Socomac / ABB / Schneider
11	Distribution Boards	Siemens (Betagard), / Hager / Schneider (Acti9) / Legrand (Ekinox3 ³ / L&T (Exora / ABB (Elegence)
12	Protection Device (MCB/RCCB/RCBO/ELCB)	Siemens (5SL), Hager / Schneider (Acti9) / Legrand (DX 3) / ABB (S200M) / L&T
13	Current transformer / potential transformer	AEL / Gilbert & Maxwell / Pragati / Precise / L&T/ Kappa
14	Indicating Lamps LED type, Push Button	Siemens / L&T / Schneider / Legrand/Teknic
15	Electronic Digital Meters	Schnider (conzerv) / L&T / Secure / Siemens / ABB / Legrand
16	MCCBs	Siemens (3VL) / L&T (D sine) / Schneider (CVS) / Legrand (DPX3) ABB (T max)
17	Power Contactor	L&T (MNX)/ Schneider (Tsys) / Legrand (CTX ³) ABB (Ax)
18	Surge Protection Devices	Siemens/L&T/Schneider / Legrand/ OBO
19	Selector Switch	Salzer/Seimens /BCH/ Kaycee / L&T
20	Auxiliary Relays	Siemens/L&T/Schneider/Legrand/ABB
21	LED Lighting Fixture	Philips/ Wipro/Havells/Crompton
22	Emergency Lighting/ Exit Sign boards	Bajaj / Prolite / Glo-Line

23	Ceiling Fan, Fresh Air Fan, Exhaust Fan	Havells/Crompton/ Usha / Orient/ Atomberg
24	Paint	Nerolac/Asian/Berger/ICI
25	Lightening Protection System	OBO/ Cape Electric/ Infinite / APS/ Jeff Techno/ Axis
26	G.I Pipe	Tata, Jindal-Hissar, Prakash Surya
27	Insulating Mat (ISI Marked)3.3KV level,	Jyoti / Deep Jyoti/ Premier
28	Fire Extinguisher (for Electrical use)	Minimax/ Life Guard / Cease Fire / Newage
29	CU/ GI Strip & GI wire for earthing	Jeff Techno/ Axis / OBO
30	MS Conduit (ISI marked)	BEC/AKG/NIC/ Steel craft/ M-Key, SK (E.R.W)
31	PVC Conduit and accessories	Polycab/ AKG / Asian
32	1.1 KV aluminum armoured XLPE insulated and PVC sheathed cable (LT cable)	Havells /KEI/ Finolex/ Gloster
33	Modular Switch & Socket	Legrand (Myrus) MK (Element) Schneider (Zencelo India) / Havells/ ABB
34	Metal Clad Industrial Socket	Legrand / Siemens/Schneider/ C&S/ ABB
35	Cat-6 cable	Belden/Sommer/Legrand/Pannet/Finolex/Havells/Kramer /Canare/D-Link
36	Crimp Patch Cord	Belden/Sommer/Legrand/Pannet/Finolex/Havells/Kramer /Canare/D-Link
37	Panel Accessories	Siemens/ L&T/ Schneider / Legrand / Tecnic/ ABB/ C&S/ Neptune
38	LED/ Metal Halide / Fluorescent Internal Lighting Fixtures	Philips/ Wipro/Havells/Crompton
39	External Lighting Fixture	Philips/ Wipro/Havells/Crompton
40	Ceiling Fan (ISI marked & BEE rated 5 star)BLDC	Havells / Almonard/ Orient/ Usha/ Bajaj
41	Advance lighting protections System (Early Streamer Emission Type)	LPI (Australia)-by allied power/ SGI (Duval Messien/ Satellite(France) by SGI/ Bradlay (USA) -by JMV/ Erico (USA) by security shoppe/ ABB
42	Main LT Panels/ MCC Panel	(Main LT panel / MCC Panel board should be IEC 61439 part-1 and II manufacturer has to produce the relevant test certificate as per IEC code for the same failing which panel shall be rejected). L&T /Siemens / Schneider/ ABB/ Legrand or their authorized channel partners for IEC 61439 compliant panels are only acceptable.
43	Air Circuit Breaker	Siemens / Schneider/ L&T/ Legrand/ C&S/ ABB
44	Surge Voltage Protection	Siemens/L&T/Schneider / ABB
45	Earth fault module	Siemens/Schneider/L&T/Legrand
46	Protection relays	Siemens/ Areva/ L&T/ Legrand
47	C.Ts and PTs	Kappa / AE/ Matrix

48	Digital Meters	Siemens (PAC)/ Schneider/ (conzerv) / Secure Enersol / L&T/ Neptune
49	Indicating lamps	ESBEE/Schneider/Siemens/Vaishno/Neptune
50	Power capacitors	Epcos/ Neptune / Legrand /ABB/ L&T
51	Automatic Power factor correction relay/controller	Epcos/Siemens (PAC) /Schneider (Conzerv)/L&T/Neptune
52	Cable Trays (Factory Fabricated/ Overhead & Floor Raceways	Legrand/MEM/OBO/ Milestone/ Neptune
53	HDPE underground cable duct	Rex Polyextrusion/ Tirpura/ Plasomatics/ Duraline
54	Insulation Mats	DL Miller & Co. Ltd./Premier Polyfilm Ltd./RMG Polyvinyl India Ltd/Jyoti
55	Smoke/Heat detectors	Apollo/ System Sensor/ Agni
56	Manual Call point	PRD/System-Tek/ Simplex/ System Sensor/ Agni
57	Response indicators	PRD/System-Tek/ Simplex/ System Sensor /Agni
58	Fire Exit Signs	System-Tek/ Simplex/ Agni
59	Fire Control Panel	System-Tek/ Morley /Agni
60	Speaker / Hooter	System-Tek/ Philips /Agni
61	Occupancy Sensors/ Movement Sensor	Legrand/ Philips/ Wipro
62	Flush type switch /socket	Anchor/ Kinjal/ SSK/ Havells Reo
63	Fuse switches unit / switch fuse unit /HRC fuse	L&T / Siemens/ Havells/ C&S
64	Exhaust fan	Almonard/ Alstom/ Crompton/ Havells
65	Cable lug	Ascon (Heavy gauge) Jainson, Dowells
66	Telephone wires/Telephone Cable / jelly filled telephone cables	Finolex /Delton/Havell's/Vindhya
67	Telephone tag blocks	Krone/ Pouyet
68	Telephone outlet	MK Electric /Legrand (Mosaic)/Crabtree (Piccadilly)
69	GI raceways	Milestone Engineering /Legrand/ MDS/ Neptune Systems Pvt. Ltd./MK
70	PVC raceways	Legrand/ MK
71	Electronic ballast	Philips / Wipro/ Bajaj/ Decon/Crompton/Havells
72	DLP plastic trunking	Legrand/MK
73	Tower Light	Ligman/Simes/Bega
74	Programmable Logic Controller (PLC)	Siemens /Allen-Bradley/ Schneider
75	Earthing (Chemical Earthing Plate Earthing	JMV/ As per CPWD Norms
76	Octagonal Pole	Bajaj / Crompton / Phillips
77	Control Relay Panel	CGL/Schneider/ABB
78	Lightning Arrestor	ABB/Alltec/JMV

79	Temp. Gauge	Guru
80	Gate Valve	Leader/Sant
81	Electrical Backup	Spare hot/ Racold
82	Thermostat	ISI Marked
83	Flat Collector Plate	Solocrome/ Tata BP/ Racold
84	S.S Sheet	Jindal / National
85	HT/LT cable joints (Straight through/outdoor/indoor)	3M/ Denson/ M Seal/Raychem/ Cabseal
86	Makes of accessories of HT / LT Panel / Transformers	As per standard practice of manufacturer/ Channel partner of L&T /Siemens / Schneider/ ABB/Legrand/Crompton Greaves
87	Bus Trunking	C&S / L&T/ Schneider as per standard practice of OEM manufacturer / channel partner
88	Bus Duct	Neptune / Milestone/ Tricolite
89	Lamp Holder (Brass)	Kay/ SSK/ Kinjal
90.	Air Conditioner Split Type 2T BEE 5Star	O Generall/ Hitachi/Bluestar/Dieken/Lloyds /Samsung/Godrej/Voltas

Any other item not covered in the above list shall be ISI marked and as approved by Engineer In Charge.

D. FIRE FIGHTING SYSTEM

Sl. No.	Details of Equipment/Material	Make/Manufacturer
1	Air Release Valve/Air Cushion Tank	Zoloto/ Advance/ Leader/ Audco/ Castle
2	Alarm Valve & Hydraulic (Alarm motor with coupling)	HD fire protect /Tyco/ Viking/
3	Ammeter/ Voltmeter/ PF/ kW/ Hz/ Meter /Energy Meter/ Multimeter	As per respective electrical make list
4	Anchor Fastener	HILTI / Fischer / Bosch/ 3M
5	Ball Valves	Audco /Zoloto/ Advance/ Sant/ Castle/NVR /Prop / L&T
6	Battery	As per electrical make list
7	Butt welded fitting (UL Listed) & accessories	Bharat Forge/ VS Forge/True Forge / DRP- M/ Metline Industries/ United Forge Industries/ Unique
8	Butterfly Valves	Audco/ Zoloto / Advance/ Castle/NVR/ Prop / L&T
9	Check Valve/Foot Valve/Sluice Valve/ NRV	Audco / Zoloto/ Advance/ Sant/ Leader/ Castle/ Honeywell / Prop / L&T
10	Control / Potential / Current Transformer	L&T/Kappa / ABB/ Siemens/ Voltamp/ Schneider / Raj Trans
11	Deluge valve/ Solenoid valve/ Spray nozzle	Victaulic/Smith Copper/Anvil/HD / Tyco/ Viking
12	Fire Buckets	Minimax/ Peter Autokits/ Padmini/ Safegaurd/ Swastik / Newage/ Cease Fire
13	Fire Stopper/ Sealant	Hilti/ 3M/ OBO-Bettermann / Kron/Nippon Paint/ Fischer
14	Fire Extinguishers	Minimax / Newage/ Eversafe/ Ceasefire/ Exflame/Life Guard/ Safex/ Padmini/ Peter Autokits
15	Fire Hydrant Valves / Fire Hose Reels/ Fire Man's Axe/ 2/ 3/4 FB inlet/ draw Out connection/Hose Box/ Hose reel drum /Nozzle/ blank Caps & Chains / Coupling	Ceasefire / Newage /Minimax/ HD/ Tyco/ Exflame / Padmini/ Aag/ Safeguard/ Lifegaurd/ Swastik
16	Flow Meter	System Sensor/ Anergy/ Emerald/ Rapid Cool/ Omicron
17	Flow Switch	Potter / Rapid flow/ Danfoss/ Viking/ Belimo/ Honeywell/ Anergy/ System Sensor/Jhonson Control/ H-Guru
18	Valve (Cast Iron/ Gunmetal)	Kirloskar / Zoloto/Advance/L&T/ Sant/ Leader/DRP
19	Forged Steel Fitting & accessories	Bharat Forge/ V.S. Forge/True Forge / DRP-M/ Metline Industries/ United Forge Industries
20	GI Clamps	Hilti/ Chilly/Kron/FISCHER
21	GI / MS Pipes	As per Civil & Plumbing make list
22	Globe Valves - Gunmetal	Audco / Zoloto/ Advance/Sant/ Leader
23	Over Load Relays	As per electrical make list
24	Pipe coat material (pipe protection)	Pypcoat / Makphalt / Safex
25	Modular Pipe Supports, Brackets, Hanging System for Plumbing & Roof Top Equipment	Hilti/ Gripple/ HIRA-Walraven/ Mupro/ Cooper Corporation/ Chilly/ GMGR /CAMRY/ Kron /Fischer
26	Pressure Gauge	Fiebig/ H. Guru/ HD/ BRC/ Waree/ Emerald/ Wika /Danfoss/Fiebig/Switzer /Plotter
27	Pressure Switch	Indfoss/ Switzer/ Danfoss/ Honeywell/ Sustem sensor/ plotter Johnson
28	Push Buttons/ Indicating Lamps LED	As per electrical make list
29	Single Phase Preventer	As per electrical make list
30	Solenoid Valve/ Spray nozzle	HD / Tyco/Danfoss/ Honeywell
31	Structural Steel for Supports	As per Civil Works make list
32	Sprinkler Heads (Sidewall/ Upright/ Pendant)	Grinnel-Tyco / Viking / HD/ Victaulic/ Monsher/ Reliable/ Newage/ HD/ Sharp / Minimax /pyrox/ Cease fire
33	Steel flexible extension	Eversafe / Newage/ Tyco/ Viking/ Victaulic /Youngjin/Lifeguard/ Guards
34	Vibration Eliminator Mounting Pads & Pipe Connections	Resistoflex / Dwren / Kanwal/ HIRA- Walraven/ Dunlop/ Easyflex/ Ewren
35	Weld Electrodes	Advani/ ESAB/ Victor/ Adorr/ Essar/Kron

36	Pot Strainer	Emerald/ VTM/ Rapid Cool/ Zoloto/ Castle/ Audco/Advance/L&T
37	Y- Strainer	Zoloto/Audco/Emerald/Advance/Leader/ Castle /Audco/Advance/L&T
38	Expansion Rubber Bellows	Resistoflex/ Easyflex/ Kanwal/ Dunlop/ Dwren / Kanex
39	Gas Flooding Sytem for Fire Suppression in Data/ LV Rooms	Newage/Minimax/Viking/ Firetrex/ Firetrace/ Kidde/ Jactone/ Honeywell/ Siemens/ Ceasefire /UTC / Safe fire/ Life guard
40	Linear Pnuematic Heat Detection Tube System for Panels	Firetrex/ UTC/ Tracefire/ Jactone/ ASES/ Rotarex/ SVS Buildwell/ Firetrace/ Kidde/ Tyco/ Siemens/ HD/
41	Clean Agent Fire Extinguisher	Kanex/Tyco/Newage/SVS Buildwell/ Minimax/ Lifeguard/Ceasefire/ Kidde/ Siemens
42	Fire Curtain & Control Panel	Minimax/Cease fire/Newage

E. FIRE AALARM SYSTEM

Sl. No.	Name of equipment/material	Make/Manufacturer
1	Intelligent Addressable Fire Alarm System - Panel /Detectors/ Hooters/ Manual Call Point UL Listed/ Control Module/ Monitor Module/ Control Relay Module/ Short Ckt. Isolator/ Fire Annunciation Panel / Response Indicator	Honeywell/ Bosch/ TYCO/ Schrack / Seconet Gamewell(USA) / Fenwell / Detnov (SPAIN) /JOHNSON CONTROL Siemens/ ABB/ L&T
2	Telephone Talkback for Fire Alarm System	Honeywell/ Bosch/ TYCO/ Siemens / Schrack/ ASES/ CPS/ Simplex /Heinrich/Notifier
3	Fire Survival Cables	Bonton/ Skytone/ Fusion Polymers/ KEI/ Havells/ Polycab / Wrexham/ Finolex/ RR Kable / Lapp Kabel/ Avocab
4	Terminal Strips	Dowell's/ Elemex/ Wago/ Phoenix Connectwell
5	MS Conduits & accessories	BEC/AKG/ RM CON /Steel Krafts

F. IPABX/EPABX & TELEPHONE SYSTEM

Sl. No.	Name of equipment/material	Make/Manufacturer
1	Telephone cable (2/4 /10 / 20/ 50/100 PAIR CABLES) / RJ -11 wires	Belden / Legrand / Finolex/ KEI/ Gloster/ Polycab/ Havells/KCJ
2	Digital/ANALOG PHONES/ Handsets/IP phones	Beetel /Panasonic /Siemens / Alcatel/ Cisco / Coral / Tadiran/Toshiba
3	IPABX / EPABX System	Alcatel/ Avaya/ Cisco/ Siemens/ Nortel/ Matrix/ Panasonic/ Coral/HP/ Tadiran /Toshiba
4	MDF/ IDF	Krone/ Hensel/A K Electronics
5	Telephone Tag Block/ Jack Panel	Krone/ Belden/ Panduit/ Legrand/ CommScope/Amp / D-Link/ Phoenix / Wago / ITL

Note.

1.This "APPROVED LIST OF MAKES" shall be followed for this work.

2. EPC Contractor shall ensure that the all materials required for this work shall be selected in order to achieve the desired Green Building rating as per tender requirements. No extra payments shall be made / any claim shall be entertained on this account under any circumstances. The bidders shall prepare their quote accordingly.

3. Specification/brands names of materials to be used as per the scope of work are listed in the bid documents. The efforts should be made by the Contractor to use indigenous products. The materials of any other brand/manufacturer may be proposed for use by the Contractor in case the brands specified below are not available in the market and/or Contractor intends to use some other brand better than the brands mentioned in this list. The alternate brand can be used only after the approval of Engineer-in-Charge.