TENDER DOCUMENT

FOR

CONSTRUCTION OF

ICAI Bhawan at Survey No.247/2, Plot "B", Chitlapakkam Village

FOR

THE INSTITUTE OF CHARTERED ACCOUNTANTS OF INDIA,
ICAI BHAWAN, PO 7100, INDRAPRASTH MARG,
NEW-DELHI – 110 002

TECHNICAL SPECIFICATIONS

ARCHITECTS:

Pithavadian and Partners, Chennai

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A. GENERAL

A. GENERAL

1. All the work will be executed as per CPWD specifications (latest editions) / IS Code (latest edition).
2. The dimensions where stated do not allow for waste, laps, joints, etc., but the Contractor shall provide sufficient labour and material to cover such waste, laps, joints etc. in his costing of rates.
3. The Contractor shall provide: Labour, maintenance, fixing, carrying, cleaning, making good, hauling, watering etc.
4. Plant, scaffolding, form work, English ladders, ropes, nails, spikes, tools, material and workmanlike protection from weather, shuttering, temporary supports, platform and the maintenance of the same.
5. All temporary canvas, lights, doors, tarpaulin, barricades, water shoots, etc. and all such temporary water-proof shades at such places and in a manner approved by the Consultant for keeping materials under cover and all requisite protection of material against sun or rain effects and for keeping the same free from water.
6. All such temporary fences, guards, approaches and roads as may be necessary for the execution of their Contract work for safeguarding or accommodating the public where they have caused interference with any fences, guards, approaches and road.
7. Cutting away for, attending upon, the making good after all trades, shall be done without any extra charges.
8. The contractor shall arrange for whole of necessary plant, concrete mixers, weigh batching plant, hoists, vibrators, scaffolding, tackle, cartage, labour and shall remove the same at the completion of the work. Employer will be the soul judge in deciding as to the suitability of the tools or plant that may be brought on the works by the Contractors, for the proper execution of the work.
9. The Contractor shall provide at his own expense, adequate closet accommodation for his workmen and keep the same in good order. The Contractor shall also provide adequate office accommodation for the Project Manager/ Architect, maintain the same in a satisfactory condition provide light and furniture for the same and remove them on completion of the works.
10. All samples, subjected to any tests, will not be returned or paid for.
11. The mixing must always be done on closely constructed platforms so that there will be no leakage of any of the materials through the floor or the platform, so that no foreign material can be incorporated during the mixing. These platforms must be approved by the Employer.
12. Two sets of measuring boxes shall be used for measuring the required proportion of matrials, for mortar or concrete, each should be for a total volume comprising each batch of mix and sizes of the boxes shall be decided in consultations with the Project Manager/ Architect. While one set of boxes being emptied into the mixer or on hte mixing platform in case of mortar, the other set shall be filled and kept ready for the next mix. At no time when the mixer is working in case of concrete or when mortar is being mixed, both sets of boxes be empty, unless with the previous sanction from Project Manager.
13. For every three wooden measuring boxes, there should be one box made of steel plate and the wooden boxes will be checked as to their correctness or volume from time to time in comparison with the steel one and the box checked with a steel measuring tape in the presence of Project Manager/ Architect. The cost of measuring boxes and platforms and all the work referred to herein shall be borne by the Contractor. The contractor or his representative shall accompany the Project Manager/ Architect when required to do so, and assist him to take measurements and shall agree to do the measurments recorded on the spot. If contractor fails to accompany the project manager / Architect or any other person duly authorized by the Employer to take measurments, he shall be bound by the measurements recorded by the Employer/ Architect/ Project Manager.
14. The odolite levels, prismatic compass, chain, steel and metallic tapes and all other surveying instrument found necessary on the works shall be provided by the Contractors for the due performance of their Contract as instructed by the Employer.

15. All measuring tapes shall be of steel and scaffolding and ladders that may be required for taking measurements shall be supplied by the Contractors.
16. If the Contractor fails to accompany the consultant of works or any other person that has been duly authorized by the employer to take measurements, they shall be bound by the measurements recorded by the Employer/Consultant or his representative.
17. The Contractor is to provide all necessary workshops and sheds for the use of workmen, and storage of materials, and are to maintain and keep the same in order to the satisfaction of the Employer and to remove them on completion.
18. The Contractor shall set out the work as per contract provisions.
19. The Contractor is to construct and maintain proper benches at the intersection of all main walls in order that the lines and levels may be accurately checked at all times.
20. Before the work is started, the whole area shall be properly and effectually cleared by the Contractors, of all such trees, roots heavy grass and obstructions as may be ordered by the Employer. No separate rate will be allowed for clearing the site.
21. The Contractor shall provide a sign board on proper supports 10' x 6' in a position approved by the Employer. The sign board shall contain the particulars stating name of work, name of Employer, name of Consultants, general Contractor and sub-Contractors; the name of the work shall be in letters not exceeding 2" in height and all to the approval of the Employer.
22. The Contractor's are to obtain licenses, and pay fees for and to provide, erect, maintain and afterwards remove all hoarding necessary, which all gates and fastening etc., to the satisfaction of the Owner and of all local authorities concerned.
23. The Contractor is to take care, in loading and unloading materials for the work, that the roads and footpaths are not obstructed, of the police regulations for carting, loading and unloading all materials, plant, earth, debris, etc. to and from the buildings.
24. The Contractor must cover up and protect all new work from injury due to any cause.
25. The general Contractor shall afford at his own cost all facilities to other Contractors free of charge, drainage and sanitary work, electrical light, fan and light work, gas cable, telephone installation and other subsidiary works.
26. The general Contractor shall provide to other Contractors free of charge, supply of water, proper storage accommodation, use of their scaffolding, and other things as required from time to time as directed by the Employer.
27. He must also supply all temporary doors, protection to windows and any other requisite protection for the whole of the works executed whether by himself or by special tradesman or sub-Contractors, and any damage caused must be made good by the Contractors at their own expenses.
28. All doors, windows and cupboard frames will be protected by encasing them with plywood or sal wood to the entire satisfaction of the Employer.
29. The Contractor is to be responsible for all pumping that may be required to keep the several works dry, down to the level of the bottom of the excavations, and to carry out the other requirements of this specification, and shall remove at his own cost the whole of the water finding its way into the same from rain springs, or any other sources, as no accumulation of water will be permitted at any time during the execution of the Contract.
30. All rubbish as it accumulated from time to time during the progress of the works, and at completion, including that of Sub-Contractors is to be cleared and carted away, and all materials rejected by the Employer are to be removed from the work, within forty eight hours.
31. The Employer shall have full powers and authority to issue such instructions as to the order of proceedings with or carrying out the work as he may deem necessary for the guidance of the Contractors and the Contractors shall be bound by such instructions of the Employer or any person or persons authorized by the Employer to give such instructions.
32. The Contractor will be responsible for the safety and structural soundness of the buildings, during the progress of all the works, and for a further period of 12 months from the date of the issue of the certificate of completion of work, by the Employer. Any defects in workmanship of materials detected during the time the works are progressing or the maintenance period, shall be replaced or made good by the Contractors at their own cost is provided in the Contract.
33. The levels and measurements of the existing site, as shown on the drawings are believed to be correct but the Contractor should verify them for himself, also examine the nature of the

ground as no claim or allowances whatever will be entertained hereafter on account of any errors of omissions in the levels or the description of the ground turning out different from what expected or shown on the drawings.

34. The Contractor shall provide all materials and labour for making good all settlements and keeping in repair the surface of any roads, footway or area upon the site during the whole period the works are in his hands, and for a period of 12 months after the completion of such work.
35. Particular care must be taken to see that the floors are not overloaded by stacks of materials during construction. It is important that no load comes on the reinforced concrete floors until they are at least three weeks old and at no time, load must be placed upon them exceeding the load for which they are designed.
36. All floors, paving, staircase, etc. are to be scrubbed, all glass to be cleaned on both sides to windows, screens, doors, sky-lights, roof-lights, etc. All gullies, pipe heads etc. to be cleared out and the premises left clean, perfect and watertight upon completion.
37. Unless specified otherwise, the cement shall be Ordinary Portland Cement grade 43.

B. TECHNICAL SPECIFICATIONS

CIVIL WORKS

B. TECHNICAL SPECIFICATIONS - CIVIL WORKS

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B. TECHNICAL SPECIFICATIONS - CIVIL WORKS

1. EARTH WORK

1.1 SCOPE OF WORK

The works covered by this section of the specifications consists of furnishing all plant, labour, equipment, appliances and materials and in performing all operations in connection with earthworks of all underground supplies and services and for all structural units, stock piling, of specifications and applicable drawings, and subject to terms and conditions of the contract. The scope of this section of specifications is also covered with detailed specifications as laid down herein.

1.2 GENERAL CONSIDERATIONS

1. The Contractor shall acquaint himself with the nature of the ground, existing structures, foundations and subsoil, which might be encountered during excavation of earthworks. The Employer does not guarantee or warrant in any way that the material to be found in the excavation will be similar in nature to that of any samples which may have been exhibited or indicated in the report, drawings or in any other contract documents or to material obtained from boring or trail holes. The contractor shall be deemed to have made local and independent inquiries and shall take the whole risk of the nature of the ground subsoil or material to be excavated or penetrated and the Contractor shall not be entitled to receive any extra or additional payment nor to be relieved from any of his obligations by reasons of the nature of such ground subsoil or material.

2. All excavations, cutting, and fills shall be constructed to the lines, levels and gradients specified with any necessary allowance for consolidation, settlement and drainage so that at the end of the period of maintenance the ground shall be at the required lines, levels and gradients. During the course of the Contract and during the period of maintenance any damage or defects in cuttings and fills, structures and other works, caused by slips, falls or basins or any other ground movement due to the Contractor's negligence shall be made good by the Contractor at this own cost.

1.3 APPLICABLE CODES

Following Codes shall be followed:

1. IS: 3764-1966 Safety Code for Excavation Work.

2. IS: 1498-1970 Classification and identification of soils for general engineering purposes.

3. British Standard 1377-Methods of test for Soils for Civil Engineering Purposes.

4. British Standard 5930- Code of Practice for Site Investigations.

5. IS: 1200 for method of measurement of building works. (Item for Excavation and Earth Work shall be measured as per plan area of PCC, working space shall not be taken into measurement, deemed to be included into rates)

6. Local Building Regulations and Statutory Regulations.

1.4 SITE PREPERATIONS

1. The Contractor shall set out the works and shall be responsible for true and perfect setting out of the same and for correctness of the positions, levels, dimensions and alignments of all parts thereof. If at any time any error in this respect shall appear during the progress of the works, the Contractor shall, at his own expense, rectify such error, to the satisfaction of the PMC/Engineer-in-charge. The Contractor shall construct and maintain accurate benchmarks so that the PMC/Engineer-in-charge can easily check the lines and levels.

2. The Contractor shall Construct and maintain such ditches, in addition to those shown on the plans, as will adequately drain areas under construction.

3. The Contractor shall perform a joint survey with the PMC/Engineer-in-charge's representative of the area where earthwork is required, plot the ground levels on the drawings and obtain approval from him before starting the earthwork.

1.5 DETAILED METHODOLOGY

1.5.1 EXCAVATIONS

1. Excavation shall include the removal of all material of every name and nature. Excavations shall be carried out in accordance with excavation plans and sections shown on the Drawings and as directed by the PMC/Engineer-in-charge.

2. The major portion of excavations shall be carried out by mechanical excavators and excavated materials disposed off to stock on spoil as per drawings or as directed by the PMC/Engineer-in-charge. The excavation, which can not be done by mechanical means including leveling, trimming and finishing to the required levels and dimensions shall be done manually. The material suitable for fill and back fill shall be stock piled within the free haulage limit of the boundary of the works.

3. The Contractor shall give reasonable notice that he intends to commence any excavation and he shall submit to the PMC/Engineer-in-charge full details of his proposals. The PMC/Engineer-in-charge may require modifications to be made if he considers the Contractor's proposals to be unsatisfactory and the Contractor shall give effect to such modifications but shall not be relieved of his responsibility with respect to such work.

4. For major excavations, the Contractor shall submit for the prior approval of the PMC/Engineer-in-charge full details and drawings showing the proposed method of supporting and strutting etc. The design, provisions construction, maintenance, and removal of such works shall be the responsibility of the Contractor and all cost in these respects shall be included in the unit rates for the permanent work.

5. The Contractor's attention is drawn particularly to his obligations under the general conditions in respect of those works which are in close proximity to existing buildings.

6. The Contractor shall preserve the complete excavation from damage from slips and earth movements, ingress of water from any source what so ever and deterioration by exposure to the sun and the effects of the weather.

7. All excavation of every description, in whatever material encountered shall be performed to the elevations and dimensions shown on the drawings in such a manner as to avoid

interruption to work in other parts of the site. The Contractor shall be responsible for injury to the permanent works caused by excavation on other parts of the works.

8. Excavation shall extend to sufficient distance from walls and footing to allow for placing and removal of forms, installations of services and for inspection, except where the concrete for walls and footings is authorized to be deposited directly against excavated surfaces. Undercutting will not be permitted. The additional excavation for placing and removal of forms, installation of services, for inspection and generally for working area on slopes for stability shall not be measured for payment and shall be deemed to be included in the rates for excavation as measured net.

9. All excavations in foundations shall be taken to 150mm and shall be trimmed carefully to a smooth and level surface, immediately after trimming to the final elevation a layer of building concrete shall be placed to the thickness shown on the drawings. All excavations for foundations which have been trimmed and disturbed shall be compacted and covered by concrete by the end of the day. It is specifically brought to the notice of the Contractor that any excavation taken down to the trimmed elevation which is left overnight or for any length of time thereafter, uncovered by the blinding concrete, shall be required to be trimmed to such lower elevation as directed by the PMC/Engineer-in-charge and any extra work or any consequent increase in the quantities caused thereby shall not be paid to the Contractor.

10. No excavation shall be refilled nor any permanent work commenced until the foundation has been inspected by the PMC/Engineer-in-charge and his permission to proceed given.

11. If excavation for sub-structures is carried below the required level, as shown in the drawings or as directed by the PMC/Engineer-in-charge, the surplus depth shall be filled in with concrete of same grade as of blinding concrete at the sole cost of the Contractor.

12. All excavation shall be performed in the dry. The placing of blinding concrete, placing of reinforcement and casting of the permanent works in the excavation shall be carried out in the dry and the Contractor shall have sufficient equipment for this purpose. Adequate precautions shall be taken to prevent any corrosion due to undercutting from underneath the previously constructed adjoining foundations.

13. Shoring, where required during excavation, shall be installed to protect the bank, adjacent paving, structures and utilities. The term shoring shall also be deemed to cover whatever methods the Contractor elects to adopt, with prior approval of the PMC/Engineer-in-charge , for upholding the sides of excavation and also for planking and strutting to excavation against the side of roadways and adjoining properties in existing hardcore of any other material. The Contractor will be held responsible for upholding the sides of all excavations and no claim for additional excavation, concrete or other material will be considered in this respect.

14. Existing utility lines that are shown on the drawings or the locations of which are made known to the Contractor prior to excavation and that are to be retained, as well as utility lines constructed during excavation and backfilling, and if damaged, shall be required to be repaired by the Contractor at his expense. Any existing utility lines which are not known to the Contractor in sufficient time to avoid damage, if inadvertently damaged during excavation, shall be repaired by the Contractor and adjustment in payment will be made as approved by the PMC/Engineer-in-charge. When utility lines which are to be removed, are encountered within the area of operations the Contractor shall notify the PMC/Engineer-in-charge in ample time for necessary measures to be taken to prevent interruption of the service.

15. Excavated material suitable for use as filling material shall be stock piled within the free haulage limit to 100m from site of works as directed by the PMC/Engineer-in-charge. This stock piled material shall be transported back to places requiring fill or backfill. Surplus or material unsuitable for use as filling shall be disposed of by the Contractor at locations approved by the PMC/Engineer-in-charge within specified free haulage limit.

16. The excavation work shall include excavation in above water table and excavations below water table. The Contractor shall submit the proposal for dewatering from the areas of excavation for the approval of Engineer and shall provide all plant, equipment, pumps, sheeting, and well points as required to keep the water table below 1.0m from the deepest foundation as shown on the drawings till the completion of foundation works.

17. The Contractor shall make independent inquiries and perform and make independent observations to ascertain the water table in the areas of excavations during the period when the construction works are in progress. The Contractor shall take whole risk of any nature for fluctuation of the water table from his own findings. The Employer is not bound in any way and shall not be responsible for any information given by him or any information, observations or values obtained from his reports, drawings and documents.

18. Excavation for pits, cable trenches and equipment foundation and other structures shall be taken out to the levels and dimensions as the PMC/Engineer-in-charge may direct.

19. Before starting the excavations, the Contractor shall ensure the correct alignment of the pipe line on the ground, the depth and width of excavation of the trench, all in accordance with the drawings and instructions of the PMC/Engineer-in-charge. The Contractor shall make profiles with cement concrete pillars.

20. Excavation shall be carried out true to line, grade and width as shown on the drawings or as directed by the PMC/Engineer-in-charge ensuring proper laying of the pipe line, the bedding fill, construction of chambers for appurtenant and any other structures. The trench bottom shall be graded to provide even and substantial bearing over the specified bedding and of the structure.

21. The Contractor at his cost shall provide to the satisfaction of the PMC/Engineer-in-charge all timbering, approved supports and shores and bracings to the sides of the excavated trench and foundations in such a manner to secure the sides of the trench and excavations from falling or adverse movement. All responsibility connected with such shoring shall rest with the Contractor. Adequate clearance / working space on both sides of the structure/pipe line shall be provided for which no payment shall be made.

22. Without the written permission of the PMC/Engineer-in-charge no more than 200.0m the trench shall be opened in advance of the completed pipeline.

23. The bottom of all excavations shall be carefully leveled. Any pockets of soft or loose material in the bottom of the pits and trenches shall be removed and the cavities so formed filled with lean concrete at the Contractor's expense.

24. The PMC/Engineer-in-charge may require the Contractor to excavate below the elevations shown on the drawings or he may order him to step above the elevations shown depending upon the suitable foundation material encountered.

25. If for any reasons, the levels grades or profiles of the excavations are changed adversely, the Contractor shall at his own cost be liable to bring the excavations to the required levels and profiles as shown on the drawings or as directed by the PMC/Engineer-in-charge.

1.5.2 EXCAVATION TOLERANCES

Excavation shall be performed within the tolerances for excavation limits indicated on the drawings. Where no tolerance limits are indicated excavation shall be performed to tolerances established by the PMC/Engineer-in-charge as accepted for the design and type of work involved.

1.5.3 BACKFILLING

1. After completion of foundation footing, foundation, walls, and other construction below the elevation of the final grades and prior to backfilling, forms shall be removed and the excavation shall be cleaned of trash and debris.

2. The backfilling shall include filling under the floors, around the foundations, trenches, pipes, conduits, ducts and channels and bedding for pipes.

3. The backfilling work shall include loading, unloading, transporting, placing, stocking, spreading of earth, watering, rolling, ramming and compacting complete as specified herein.

4. Filling shall be approved selected material from excavation or other predominantly granular material and free from slurry, mud, organic or other unsuitable matter and capable for compaction by ordinary means.

5. The excavated material if found suitable shall be stock piled within the free haulage limit of the site of the works. This material shall be used for backfilling if approved by the PMC/Engineer-in-charge and shall be transported by the Contractor any where required for the purpose of backfilling work in this contract.

6. The Contractor shall provide the approved quality fill and backfilling material as required to complete the fill/backfilling work.

7. Filling in trenches and foundation shall be placed in 200 mm layers and compacted at optimum moisture content by mechanical means or other means as approved by the PMC/Engineer-in-charge .

8. Fill in around pipes and cables shall be carefully placed with fine material to cover the pipe or cable completely before the normal in filling is done.

9. Material for back filling shall be as approved by the PMC/Engineer-in-charge and shall be placed in layers of 150 mm measured as compacted material and saturated with sufficient water and compacted to produce in-situ density not less than 95% of the maximum density at optimum moisture content, achieved in Test No.15 of BS 1377:1975 or similar clause of relevant IS Code.

10. All filled areas shall be left neat, smooth and well compacted with the top surface consisting of the normal site surface soil unless otherwise directed.

11. Depending on the depth of fill the PMC/Engineer-in-charge may instruct increased thickness of successive layer to be placed.

12. Fill shall not be placed against foundation walls prior to approval by the PMC/Engineer-in-charge. Fill shall be brought up evenly on each side of the walls as far as practicable. Heavy equipment for spreading and compacting the fill shall not be

operated closer to the wall than a distance equal to the height of the fill above the top of footing.

13. In case the Contractor is instructed to arrange for the fill material the quality of the fill material will be subject to the approval of the PMC/Engineer-in-charge. The PMC/Engineer-in-charge shall require the Contractor to carry out various tests of the fill material. All such tests shall be made at an approved laboratory at the cost of the Contractor. Once a material from a specific source has been approved, the material for the same quality and from that source only shall be used. Any fill material from borrow pits which has not been approved or the quality of which differs from the approved material shall be rejected out rightly. The PMC/Engineer-in-charge reserves the right to order removal of any such materials brought to the site of works at his discretion at Contractor's expense. In order to ensure satisfactory compaction, it will be necessary to carry out, depending upon the type of material, particle size distribution tests, determination of organic content tests, maximum and minimum density tests and determination of optimum moisture content for the filling material.

14. The method of compaction, namely type of compactor, type of roller, weight of roller and number of passes proposed by the Contractor for any particular fill material shall be subject to the approval of the PMC/Engineer-in-charge after completion of satisfactory field tests, subsequent to the laboratory analyses, using the materials and equipment proposed to be used for the earth work in conditions similar to those likely to be encountered during construction. The final selection of the soil moisture content, the thickness of layers, the type of compaction equipment and the number of passes shall be decided after these tests, which shall be conducted at Contractor's expense.

15. Having established the method of compaction to be used, no departure from this approved method shall be permitted without the prior approval of the PMC/Engineer-in-charge. Adequate control of the fill and compacting operations shall be ensured by in-situ density tests and in order to obtain significant results, not less than two measurements shall be carried out per one hundred square meters of area compacted. The frequency of tests shall be determined on site and may be varied at the discretion of the PMC/Engineer-in-charge. Compaction shall not be less than 95% in-situ density with respect to the maximum density, at optimum moisture content.

16. The exact thickness of layers and the method of placing and compacting the fill shall be determined by the field tests, as stated above, but not withstanding the results of these trails, fill shall not be placed in layers exceeding 200mm in thickness. In order to maintain control of the thickness of layers, timber profiles shall be used wherever feasible. The travelers of such profiles for each layer of fill shall be checked by the supervisory staff of the PMC/Engineer-in-charge. The Contractor shall provide adequate supply of water and sufficient capacity of mechanical water carriers to ensure uniform and uninterrupted operation of compaction. The PMC/Engineer-in-charge may forbid the Contractor to proceed with placing and/or compaction of fill and/or order removal and re-compaction of such fill when he finds that the Contractor has insufficient or defective equipment or that the fill has been improperly laid and/or compacted.

17. If it is found necessary to alter the moisture content of the fill material in any way, then very strict control shall be exercised over the wetting and/or the drying process and frequent moisture content tests.

18. The fill material should be well graded non-cohesive and nearly silt-free (silt content between 5 to 10 percent) salt free and fee of organic materials (less than 2%). It should also be free of stones larger than 100 mm. maximum dimension. It should be of such nature and characteristics that it can be compacted to the specified densities in

reasonable length of time. It shall be free of plastic clays, of all materials subject to decay, decomposition or dissolution and or cinder or other material which corrode piping and other metals.

SAND

Sand shall be clean and free from dust, organic and foreign matter and corresponding to grading Zone V or IV, meeting the approval of the Engineer.

MOORUM

Moorum shall be of approved quality and shall be brought from approved source.

FILLING WITH SAND/ MOORUM

Sand filling shall be done in a manner similar to earth filling in plinth as specified in 1.5.3, except that consolidation shall be done by flooding with water. The surface of the consolidated sand/ moorum shall be dressed to required level or slope. Concreting of floor shall not be started till the Engineer has inspected and approved of the sand filling.

1.5.4 TOLERANCES

The stabilization of compacted backfill/ fill surfaces shall be smooth and even and shall not vary more than 100mm in 3 meters from true profile and shall not be more than 12.5mm from true elevation.

1.5.5 DISPOSAL OF SURPLUS MATERIAL

1. The rejected unsuitable material and surplus excavated material shall be disposed of within 200 m free haulage limit measured from boundary of the works to places or as directed by the PMC/Engineer-in-charge.

2. The disposal of surplus excavated material shall include loading, unloading, transporting, stacking, spreading as directed by the PMC/Engineer-in-charge.

3. All excavated material not so used shall only be disposed of in areas identified by the Contractor approved by the PMC/Engineer-in-charge. Such areas will be well drained and the deposited material left in a tidy and stable condition to the Engineer's approval.

1.6. ROUTINE TESTS

1. TESTING OF FILL MATERIALS:

Tests shall be executed by an independent testing agency. In executing following tests comply with IS Standards:

a. Sampling
b. Sample preparation
c. Sieve analysis
d. Liquid limits
e. Plastic limit and plasticity index
f. Moisture content
g. Moisture density relationship

h. Sand equivalent
i. Specific gravity
j. Sand core density
k. Rubber balloon density
l. Classification
m. Carry out moisture density tests on representative samples prior to placing
n. Carry out gradation of materials prior to placing as the work proceeds
o. Carry out site density tests of materials as the work proceeds and as follows:

2. FREQUENCY OF TESTS

a. STRUCTURAL FILL

i) One test for each 500 Cum. placed.

ii) One test whenever there is a change of gradation or placement conditions.

b. GENERAL FILL

i) One test for each 3000 Cum. placed.

ii) One test whenever there is a change of gradation or placement conditions.

iii) Execute site density tests for compaction at a minimum depth of 100 mm below compacted surface.

iv) Execute a full compaction test or a one-point compaction test in conjunction with each site density determination.

v) Execute a gradation test with each site density test and whenever there is an apparent change in material being placed.

vi) Execute the following site density tests and laboratory moisture density tests to evaluate compaction achieved:

vii) One test for every 200-400 cu.m. of backfill in trenches or surrounding structures.

viii) One test for every full shift of compaction operations on mass earthwork.

1.7 MODE OF MEASUREMENTS

1.7.1 GENERAL

Except otherwise specified herein or elsewhere in the Contract documents, no measurement and payment will be made for the under mentioned specified works related to the relevant items of the bill of quantities. The cost thereof shall be deemed to have been included in the quoted unit rate of the respective items of the bill of quantities.

1. Dewatering, where required, to keep the foundation trenches dry during construction of works.

2. Timber shoring, planking, strutting and providing slope for up-holding the sides of excavations.

3. Any fill with approved material necessitated by over excavation due to fault or negligence of the Contractor.

4. Stock piling of the excavated material at approved locations with 300m free haulage limit and transporting back suitable material to places requiring fill or backfill.

5. Specified foundation bed preparation.

6. Excavation involved in providing sufficient working space around sides of foundation and service line trenches.

7. Providing approved quality fill/backfill material from outside sources. Royalty for borrow areas and haulage of material shall not be paid for separately.

8. Rolling, leveling, watering and compacting the fill and backfill to required density.

9. All laboratory and field tests stipulated in these specifications.

10. Disposal of rejected unsuitable and surplus excavated material within 200m free haulage limit measured from the fence boundary of site of works following the shortest route as directed by the PMC/Engineer-in-charge.

1.7.2 EXCAVATION

A. MEASUREMENT

Quantities of excavation shall be calculated / measured from the pre-work levels of natural ground taken jointly by the Contractor and the PMC/Engineer-in-charge before commencement of the work.

The quantities set out for excavation and its subsequent disposal shall be deemed to be the bulk before excavating and no allowance shall be made for any subsequent variations in bulk or for any extra excavation unless otherwise shown on the drawings quantities of excavation shall be measured on the basis of vertical excavations required for the nominal concrete dimensions of the structural members of foundations. Lean concrete shall not be construed as structural concrete.

Quantities of excavation for service line trenches shall be measured for payment on the basis of vertical excavation faces for the specified width as shown on the drawings. Measurement for acceptably completed excavation works shall be made on the basis of number of cubic meter of material excavated for foundation and service trenches as shown on the drawings or as directed by the Consultant's PMC/Engineer-in-charge.

B. PAYMENT

Payment will be made for acceptable measured quantity of excavation on the basis of unit rate per cubic meter. quoted in the bill of quantities and shall constitute full compensation for all the works related to the item.

1.7.3 BACKFILL / FILLS

A. MEASUREMENT

Measurement for acceptable completed backfill/ fill works shall be made on the basis of number of cubic meter of compacted backfill/ fill in position, or as shown on the drawings or as directed by the PMC/ENGINEER-IN-CHARGE.

B. PAYMENT

Payment will be made for acceptable measured quantity of backfill/ fill on the basis of unit rate per cu.meter quoted in the bill of quantities and shall constitute full compensation for all the works related to the item.

2. ANTI-TERMITE TREATMENT

2.1 GENERAL CONSIDERATIONS

1. All the buildings shall be adequately protected against attack by sub terrain termites by suitable chemical treatment measures. The work shall be carried out by a specialist pest control agency approved by Consultants/ Architect/ Client. The work to be carried out by the specialist firm shall carry a guarantee for the satisfactory performance of the treatment for a min.period of ten (10) years.

2. Prevention of termite from reaching the superstructure can be achieved by creating a chemical barrier between the ground and the building by treating the soil beneath the building and around the foundations. To have proper check for uniform, spraying of chemical, graduated containers shall be used. Proper check should be kept that the specified quantity of chemical is used for the required area during the operation.

2.2 APPLICABLE CODES

The Anti termite treatment shall be carried out generally in accordance with the stipulation laid down by to the following:

1. IS 6313 (Part I) - Code of practice for anti termite measures in buildings Constructional Measures

2. IS 1200 (Part I) – Method of Measurement of buildings and civil engineering works

3. IS 6313 (Part II) - Pre constructional chemical treatment measures

4. IS 8944 - Specification for Chloropyrifos Emulsifiable Concentrates

5. IS 4015 (Part I) – Guide for Handling cases of Pesticide Poisoning First Aid Measures

6. IS 4015 (Part II) – Symptoms, Diagnosis and Treatment

2.3 SITE PREPERATIONS

In order to ensure uniform distribution of the chemical emulsion and to assist penetration, the following site preparation shall be carried out:

1. Remove all trees, stumps, logs, or roots from the building site.

2. Remove all concrete formwork if left anywhere, leveling pegs, timber off cuts and other building debris from the area to be treated.

3. If the soil to be treated is sandy or porous, preliminary moistening will be required to fill capillary spaces in order to prevent the loss of emulsion through piping or excess percolation.

4. In the event of water logging of foundation, the water shall be pumped out before application of chemical emulsion and it should be applied only when the soil is absorbent.

5. On Clays and other heavy soil, where penetration is likely to be slow and on sloping sites and where runoff of the treating solution is likely to occur, the surface of the soil should be at least to a depth of 25mm.

6. Surface areas to receive the anti- termite treatment should be suitably leveled and compacted strictly in accordance with the manufacturers' recommendations. All cutting, trenches and excavation should be completed with back filling in place. Borrowed fill must be free from organic debris and shall be well compacted. If this is not done, supplementary treatments should be made to complete the barrier. A certificate from the PMC/ ENGINEER-IN CHARGE, in compliance of above is must before the application of treatment.

2.4 MATERIAL SPECIFICATIONS

The earth filling immediately under the stone soling (under floors) bottom and side fills of all foundations (excepting foundations) and soil along external perimeter of all buildings shall be chemically treated against termites. The chemical to be used for the treatment shall be Dildrin, Aldrin, Heptachlor or Chlordane or as specified, conforming of the requirement and concentration lay down in IS 6313 (Part II) - latest edition.

MOUND TREATMENT: For a mound volume of about one cubic meter, four litres of an emulsion in water with 0.50 percent Chloropyrifos may be used

2.5. DETAILED METHODOLOGY

2.5.1 TIME OF APPLICATION

Soil treatment shall start when foundation trenches and pits are ready to take mass concrete in foundations. Laying of mass concrete shall start when the chemical emulsion has been absorbed by the soil and the surface is quite dry. Treatment should not be carried out when it is raining or when soil is wet with rain or sub-soil water. The foregoing applies also in the case of treatment to the filled earth surface within the plinth before laying the sub grade for the floor.

2.5.2 DISTURBANCE

The treated soil barriers shall not be disturbed after they are formed. If by chance, treated soil barriers are disturbed, immediate steps shall be taken to restore the continuity and completeness of the barrier system.

2.5.3 TREATMENT OF COLUMN-PITS, WALL-TRENCHES AND BASEMENT-TANKS EXCAVATION.

1. The bottom surface and the sides (up to a height of above 300 mm) of the excavation made for column pits, wall trenches and basements shall be treated with the chemical at the rate specified in IS 6313 (1981) Part II of 1981.

2. After the column foundations and the retaining wall of the basement come up, the backfill in immediate contact with the foundation structure shall be treated at the rate specified in IS 6313 of the vertical surface of the sub-structure for each side. If water is used for ramming the earth fill, the chemical treatment shall be carried out after the ramming operation is done by rodding the earth at 150mm centers close to the wall surface and spraying the chemical with the above dose. The earth is usually returned in layers and the treatment shall be carried out in similar stages. The chemical emulsion shall be directed towards the concrete or masonry surfaces of the columns and walls so that the earth in contact with these surface is well treated with the chemicals.

3. In the case of R.C.C. framed structures with columns and plinth beams and R.C.C. basements/ tanks with concrete mixes rich and dense (being 1:2:4 or richer), it is unnecessary to start the treatment from the bottom of excavation for columns and plinth beams. The treatment shall start at the depth of 500mm below ground level. From this depth the back-fill around the columns, beams and R.C.C basement wall shall be treated at the rate as per IS 6113 Part II. The other details of treatment shall be as laid down in the clause 3.6.2 above.

2.5.4 TREATMENT OF TOP SURFACE OF PLINTH FILLING

The top surface of the filled earth within plinth wall shall be treated with chemical emulsion at the rate as per IS 6313 Part II (surface area) before the sand/sub grade is laid. Holes up to 50 to 75mm deep at 150mm centers both ways shall be made with crowbars on the surface to facilitate saturation of the soil with chemical emulsion.

2.5.5 TREATMENT OF INNER WALL SURFACES

To achieve continuity of the vertical chemical barrier on inner wall surfaces from the ground level, small channel 30 x 30mm shall be made at all the junctions of wall and columns with the floor (before laying the sub grade) and rod holes made in the channel up to ground level 150mm apart and the chemical emulsion poured along the channel as per rate of application, mentioned in IS 6113 Part II (1981) so as to soak the soil right up to bottom. The soil shall be tamped back into place after this operation.

2.5.6 TREATMENT OF SOIL ALONG EXTERNAL PERIMETER OF BUILDING

During progress of work, provide holes in the soil with iron rods along the external perimeter of the building at intervals of about 150mm and depth 300mm and filling these holes with chemical emulsion at the rate (as per IS 6313 Part II) per meter of perimeter of the external wall.

2.5.7 TREATMENT FOR EXPANSION JOINTS

Anti-termite treatment shall be supplemented by treating through the expansion joint after the sub-grade has been laid as per IS-6313 Part II of 1981. The soil beneath the expansion joints shall receive special attention when the treatment under 2.5.3 above is in progress. This treatment shall be supplemented by treating through the expansion joint after sub grade has been laid at the rate of 2 liters per meter length of the expansion joint.

2.5.8 TREATMENT OF SOIL SURROUNDING CONDUITS

When pipes and conduits enter the soil inside the area of the foundations, the soil surrounding the points of entry shall be loosened around each such pipe or conduit for a distance of 150mm and to a depth of 75mm before treatment is commenced. When they enter the soil external to

the foundations, they shall be similarly treated unless they stand clear of the walls of the building by about 75mm for distance of over 30mm from ground level.

2.6. WORKMANSHIP

Only professionals with min. 5 years experience in this type of work shall be employed to carry out the anti- termite treatment required.

2.7. EQUIPMENT AND ACCESSORIES REQUIRED

To facilitate proper penetration of the chemical into the soil, a pressure pump of adequate capacity and sprayers shall be employed to apply the solution.

2.8. MODES OF MEASUREMENTS

The measurements shall be made in square meter on the basis of plinth area of the building at ground floor only for all operations described in schedule of quantities. Nothing extra shall be measured. The rate shall include cost of all material and labour involved in all operations described above.

2.9. SAFETY PRECAUTIONS

1. PRECAUTIONS DURING TREATMENT

a) Utmost case shall be taken to see that the chemical barrier is complete and continuous. Each part of the area shall receive the prescribed dosage of chemical emulsion

b) The treatment should not be carried out when it is raining or when the soil is wet with rain or sub soil water.

c) Once formed, the treated soil barrier shall not be disturbed. If any chance, treated soil barriers are disturbed, immediate steps shall be taken to restore the continuity and completeness of the barrier system.

2. PRECAUTIONS FOR HEALTH HAZARDS AND SAFETY MEASURES

a) All chemicals used for anti-termite treatment are poisonous and hazardous to health. These chemicals can have an adverse effect upon health when absorbed through the skin, inhaled as vapors or spray mists or swallowed. Person using or handling these chemicals should be warned of these dangers and advised that absorption through the skin is the most likely source of accidental poisoning. They should be cautioned to observe carefully the safety precautions given below.

b) These chemicals are usually brought to site in the form of emulsifiable concentrates. The containers should be clearly labeled and should be stored carefully so that children and pets cannot get at them. They should be kept securely closed.

c) Particular care should be taken to prevent skin contact with concentrates. Prolonged exposure to dilute emulsions should also be avoided. Workers should wear clean clothing and should wash thoroughly with soap and water, especially before eating and smoking. In the event of severe contamination, clothing should be removed at once and the skin washed with soap and water. If chemicals splash into the eyes they should be flushed with plenty of fresh water and immediate medical attention should be sought. The concentrates are oil solutions and present a fire hazard owing to the use of petroleum solvents. Flames should not be allowed nearby during the mixing. Care should be taken in the application of chemicals to see that they are not allowed to contaminate wells or springs that serve as sources of drinking water.

2.10 . GUARANTEE

1. On completion of the treatment in all respects, a guarantee that the building is safe from subterranean species of termite infestation for a period of 10 years is required on stamp paper in a format which shall be approved by the Engineer-in-charge who shall have the final decision.

2. In the event of re-infestation of the said structure at any time during guarantee period, an undertaking is required to carry out such treatment as may be necessary to render the structure free from termite infestation without any extra cost including any remedial work, resulting sleeves, cutout etc.

3. CONCRETE WORK

3.1 SCOPE OF WORK

The work covered by this section of the Specifications consists of furnishing all plant, labour, equipment, appliances and materials, and in performing all operations in connection with the supply and installation of plain and reinforced concrete work, complete in strict accordance with this section of the Specifications and relevant documents, subject to the Conditions of the Contract.

3.2 GENERAL CONSIDERATIONS

1. Full co-operation shall be given to other trades to install embedded items and/or any associated services.

2. Embedded items shall have been inspected, and tests for concrete and other material or for mechanical operations shall have been completed and approved, before concrete is placed.

3. Formwork shop drawings shall be designed and prepared by the Contractor at his own cost. Approval of shop drawings as well as those of mock-ups /actual samples of finished concrete shall be obtained before Work is commenced.

4. Contractor shall prepare BAR BENDING SCHEDULES, and get the same approved by the PMC/ engineer-in- charge, prior to commencement of work.

3.3 APPLICABLE CODES

IS - 299	Specification for Ordinary, rapid hardening and low heat Portland Cement
IS - 455	Specification for Portland blast furnace slag Cement
IS 1489-	Specification for Portland Pozzolona Cement
IS 4031-	Method of physical tests for Hydraulic Cement
IS - 650	Specification for standard sand for testing of Cement
IS - 383	Specification for Coarse and Fine aggregate for use in mass concrete
IS - 515	Specification for natural and manufactured aggregate for use in mass concrete.
IS 2387-	Method of test for aggregates for concrete.

IS - 516	Methods of test for strength of concrete.
IS 1199-	Methods of sampling and analysis of concrete
IS 3025-	Methods of sampling and test (physical and chemical) for water used in industry.
IS 2645-	Specification for integral cement water proofing compounds
IS 1791-	Specification for batch type concrete mixers
IS 2438-	Specification for roller pan mixer
IS 2505-	Specification for concrete vibrators, immersion type
IS 2506-	Specification for screed board concrete vibrator
IS 2514-	Specification for concrete vibrating tables
IS 3344-	Specification for pan vibrators
IS 4656-	Specification for form vibrators
IS 2722-	Specification for portable swing weigh batchers for concrete (single & double bucket type)
IS - 456	Code of practice for plain and reinforced concrete
IS 1343-	Code of practice for pre-stressed concrete
IS - 457	Code of practice for general construction of plain and reinforced concrete for dams and other massive structures.
IS 3370-	Code of practice for concrete (Part I to IV structures for storage of liquids
IS 3935-	Code of practice for composite construction
IS 3201-	Criteria for design and construction of precast concrete trusses.
IS 2204-	Code of practice for construction of reinforced concrete shell roof.
IS 2210-	Criteria for the design of R.C. shell structures and folded plates.
IS 3558-	Code of practice for use of immersion vibrators for consolidating concrete
IS 3414-	Code of practice for design and installation of joints in buildings
IS 2571-	Code of practice for laying in situ cement concrete flooring

In addition to the above mentioned codes the PMC/ Engineer-in- charge may specify any other standard for special materials and construction.

3.4 SUBMITTALS

A. MATERIALS REPORTS

Prior to start of delivery of materials required for cement concrete the following shall be submitted by the Contractor to the Engineer for approval.

1. Recommended suppliers and/or sources of all ingredients for making concrete including cement, fine and coarse aggregates, water and additives including samples thereof.
2. Quality Inspection Plan to ensure continuing quality control of ingredients by periodic sampling, testing and reporting to the Engineer on the quality of materials being supplied.

B. MIX DESIGN

1. The Contractor shall design mixes for each class of concrete indicating that the concrete ingredients and proportions will result in concrete mix meeting requirements as specified.

2. Well in advance to commencement of concreting work the contractor shall submit the proposal of mix design and test results from approved laboratory thereof as a report for the approval of the Engineer.

C. PLANT AND EQUIPMENT

The contractor shall submit the proposed programme, methods and details of plant and equipment to be used for batching, mixing of concrete and transportation of concrete to the Engineer, well in advance prior to start of work.

D. CERTIFICATES

1. With each mix design, the Contractor shall submit laboratory test reports on concrete cubes and as well as on ingredients along with manufacturer's certificates attesting that ingredients have been taken from materials to be used at the actual construction work and conforms to specifications for approval of the Engineer.
2. In case the source, brand or characteristic properties of the ingredients are required to be varied during the term of the contract, a revised laboratory mix design report shall be submitted to the Engineer.

E. REPORTS FOR INSPECTION AND TESTING

During concreting operations, the contractor shall conduct necessary inspection and testing as prescribed in IS codes and shall be submitted to the Engineer.

F. SCHEDULES

The Contractor shall prepare working schedules for dates and quantity, location of pouring of concrete for each item of work and submit same to the Engineer at least 48 hours before commencement of such work.

3.5 MATERIAL SPECIFICATIONS

Before bringing to the site, all materials for cement concrete shall be approved by the Engineer. All approved samples shall be retained in the office of the Engineer before placing orders for the materials with suppliers. The materials brought on to the works shall conform in every respect to their approved samples.

Fresh samples shall be delivered to the Engineer whenever type or source of any material changes. The contractor shall check each fresh consignment of materials as it is brought on to the works to ensure that they conform to the specifications and/or approved samples.

The Engineer shall have the option to have any of the materials tested to find whether they are in accordance with specifications. All bills, vouchers and test certificates which in the opinion of the Engineer are necessary shall be produced for his inspection when required.

Any materials which have not been found to conform to the specifications and not approved by the Engineer shall be removed from the site by the contractor within the time stipulated by the Engineer.

3.5.1 CEMENT

1. The cement used shall be Ordinary Portland Cement conforming to IS 8112: 1989 (43 grade).

2. Whenever possible all cement of each type shall be obtained each from one constant source throughout the contract. Cement of different types shall not be mixed with one another.

Different brands of cement, or the same brand of cement from different sources, shall not be used without prior notification and approval

3. The cement shall be supplied either packed in bags or in silos installed for the purpose of supply. Packed cement shall be delivered to the site in original sealed bags which shall be labeled with the weight, date of manufacture, name of manufacturer, brand and type. Cement received in torn bags shall not be used. Moreover bags of cement which vary in weight by more than 3% shall not be accepted.

4. In fair faced elements, the cement used in the concrete for any complete element shall be from a single consignment. All cement for exposed concrete shall be from the same approved source and uniform in color.

5. With each and every delivery of cement the contractor shall provide the manufacturer's certificate that the cement conforms to the relevant Indian Standard.

The Contractor shall provide facilities for making 7 days tests from time to time in accordance with IS:3535: 1986, IS:4031 (Latest edition) and IS:4032 : 1985 and shall allow for carrying out such tests as may be required by the Engineer and for reporting the results.

3.5.2 AGGREGATES

1. Aggregates from natural sources shall be in accordance with IS – 383: 1970. The Contractor shall submit to the Engineer certificates of grading and compliance from the suppliers for all consignment of aggregate. In addition from time to time, the Contractor shall test that aggregate at site in accordance with IS – 2386: 1963 (Parts 1, 2 & 3). The contractor shall allow for and provide all necessary apparatus for carrying out such tests and for supplying test records to the Engineer. The aggregates shall be free from salts or other harmful chemical impurities.

2. For fair faced concrete, the contractor shall ensure that aggregates are free from iron pyrites and impurities which may cause discolouration.

3. FINE AGGREGATE

   a) The fine aggregate shall be pit sand or stone dust or other Badarpur sand as approved by the Engineer. It shall be free from clay, loam, earth or vegetable matter and from salt or other harmful chemical impurities. It shall be clean, sharp, strong, angular and composed of hard siliceous material. Fine sand shall be within the limits of Grading Zone-IV given in Table I. When the grading falls outside the percentage limits given for sieve other than 600 micron, 300 micron and 150 micron (I.S.) sieve but not more than 5%, it shall be regarded as falling within this Zone. The 5 per cent shall be summation of excess on all other sieves.

TABLE

I.S. Sieve Designation	Percentage Passing for Grading			
	Zone-I	Zone-II	Zone-III	Zone-IV
10 mm	100	100	100	100
4.75 mm	90-100	90-100	90-100	95-100
2.36 mm	60-95	75-100	85-100	95-100
1.18 mm	30-70	55-90	75-100	90-100
600 micron	15-34	35-59	60-79	80-100
300 micron	5-20	8-30	12-40	15-50
150 micron	0-10	0-10	0-10	0-15

b) For coarse sand the grading of sand as determined by the method prescribed in IS – 2386 (Part-I): 1963 shall be within the limits of Grading Zone III given in Table I. When the grading falls outside the percentage limits given for sieves other than 600 micron, 300 micron and 150 micron (I.S.) sieves but not more than 5 percent, it shall be regarded as falling within this zone. The 5 percent can be excess summation on one or more sieves.

c) The maximum quantity of silt as determined by the method prescribed in I.S - 2386 (Part 2): 1963 shall not exceed 8 percent.

d) Stone dust shall be obtained by crushing hard stone and the grading as determined by the method prescribed in IS – 2386 (Part-1 & 2): 1963. It shall be within the limits of grading Zone-III. The percentage of limits above for the sieves other than 600 microns and 300 micron sieves shall not be more than 5 percent and for 150 micron sieve shall not be more than 20 percent. This shall then be regarded as falling within this zone. The 5 percent shall be summation of excess on other sieves.

4. COARSE AGGREGATE

a) The coarse aggregate shall be crushed stone, approved river shingle or pit gravel having nominal maximum size of 20 mm and down as approved by Engineer.

b) Coarse aggregate obtained from crushed or broken stone shall be angular, hard, strong, dense, durable, clean and free from soft, friable, thin flat, elongated or flaky pieces.

c) River shingle or pit gravel shall be rounded, sound, hard, clean, nonporous, suitably graded in size with or without broken fragments and free from flat particles of shale, clay silt, loam and other impurities.

d) Except where it can be shown to the satisfaction of the Engineer that a supply of properly graded aggregate of uniform quality can be maintained over the period of the works, the grading of aggregate shall be controlled by obtaining the coarse aggregate in different sizes and blending them in correct proportions as and when required.

3.5.3 WATER

1. Water used in the works shall be potable water and free from deleterious materials. Water used for mixing and curing concrete as well as for cooling and/or washing aggregate shall be

fresh and clean, free from injurious amounts of oil, salts, acids, alkali, other chemicals and organic matter.

2. Water shall be from the source approved by the PMC/ Engineer-in-charge and shall be in accordance with clause 5.4 of IS-456: 2000.

3. Before starting any concreting work and wherever the source of water changes, the water shall be tested for its chemical and other impurities to ascertain its suitability for use in concrete for approval of the Engineer. No water shall be used until tested and found satisfactory.

3.5.4 ADMIXTURES AND ADDITIVES

1. Chemical admixtures shall conform to IS-9103:1979 and are not to be used unless permitted by the Engineer. In case their use is permitted, the type, amount and method of use of any admixture proposed by the contractor shall be submitted to the Engineer for approval.

2. The contractor shall further provide the following information concerning each admixture to the Engineer.

   a) Normal dosage and detrimental effects if any of under dosage and over dosage.

   b) The chemical names of the main ingredients in the admixture.

   c) The chloride ion content if any expressed as a percentage by weight of admixture.

   d) Whether or not the admixture leads to entrapment of air when used in the manufacturer's recommended dosage.

   e) Where two or more admixtures are proposed to be used in any one mix, the manufacturer's written confirmation of their compatibility.

3. In reinforced concrete, the chloride ion of any admixture used shall not exceed 2 percent by weight of the admixture as determined in accordance with IS-6925: 1973 and the total chloride ion in all admixtures used in concrete mix shall not exceed 0.83 percent by weight of cement.

4. The admixtures when used shall conform to IS-9103:1979. The suitability of all admixtures shall be verified by trial mixes.

5. The addition of calcium chloride to concrete containing embedded metal will not be permitted under any circumstances.

6. Retarding admixtures when used shall be based on lignosulphonates with due consideration to clause 5.2 and 5.3 of IS-7861 (Part 1): 1975.

7. Waterproofing admixtures shall comply with IS-2645:1975.

3.6 PROPORTIONING, BATCHING & MIXING OF CONCRETE

A. PROPORTIONING

1. AGGREGATE

The proportions, which shall be decided by conducting preliminary tests shall be by weight. These proportions of cement, fine and coarse aggregates shall be maintained during subsequent concrete batching by means of weight batchers conforming to I.S. 2722 capable of controlling the weights within one percent of the desired value. Except where it can be shown to the satisfaction of the Architect/ Client that supply of properly graded aggregate of uniform quality can be maintained over the period of work, the grading of aggregate shall be controlled by obtaining the coarse aggregate in different sizes and blending training the coarse aggregate in different sizes and blending them in the right proportions. The different sizes shall be stocked in separate stockpiles. The grading of coarse and fine aggregate shall be checked as frequently as possible, as determined by Architect/ Client to ensure maintaining of grading in accordance with the samples used in preliminary mix designs. The material shall be stockpiles well in advance of use.

2. CEMENT

The cement shall be considered by weight, for design mix.

3. WATER

Only such quantity of water shall be added to the cement and aggregates in the concrete mix as to ensure dense concrete, specified surface finish, satisfactory workability, consistent with the strength stipulated for each class of concrete. The water added to the mix shall be such as not to cause segregation of materials or the collection of excessive free water on the surface of the concrete.

4. DEFINITION OF WATER/CEMENT RATIO

The water cement (W/C) ratio is defined as the weight of water in the mix (including the surface moisture of the aggregates) divided by the weight of cement in the mix.

The actual water cement ratio to be adopted shall be determined in each instance by Contractor and approved by the Architect/ Client.

5. PROPORTIONING BY WATER/CEMENT RATIO

The W/C ratio specified for use by Architect/ Client shall be maintained. Contractor shall determine the water content of the aggregates as frequently as desired by the Architect/ Client as the work progresses and as specified in IS 2386 (Part III) and the amount of mixing water added at the mixer shall be adjusted as directed by the Architect/ Client so as to maintain the specified W/C ratio. To allow for the variation in their moisture content, suitable adjustments in the weights of aggregates shall also be made.

B. BATCHING AND MIXING OF CONCRETE

1. The proportions of the materials for the concrete mix as established by the preliminary test for mix design shall be followed for all the concrete in the works and shall not be changed except when specifically permitted by the Architect/ Client.

2. If approved by the Architect/ Client concrete may be produced by volume batching the ingredients except the cement. Fine and coarse aggregate shall be proportioned volumetrically by subsequent conversion of the weights of volumes knowing their bulk densities as stipulated in Para 9.2.2 or I.S. 456-2000. All concrete shall be mixed in mechanically operated batch mixers complying with I.S. 1791 of approved make with suitable provisions of correctly controlling water delivered to the drum. The quality of water actually entering the drum shall be checked with reading of gauge or valve setting before starting the job. The test shall be made while mixer is running. The volume of the mix material shall not exceed the manufacturer's rated mixer capacity. The batch shall be charged into the mixer so that some water will enter the drum in advance of cement and aggregates. All water shall be in the drum by the end of 15 seconds of the specified mixing time. Each batch shall be mixed until the concrete is uniform in colour for the minimum period of 2 minutes after all the materials and water is in the drum. The entire contents of the drum shall be adjusted in one operation before the raw materials for succeeding batches are fed into the drum. The entire contents of the drum shall be adjusted in one operation before the raw materials for succeeding batches are fed into the drum. The weighing gauge of mix shall be periodically checked or as directed by the Architect/ Client. The contractor should carry our rectifications immediately if found necessary.

3. Mixer and the weight batcher shall be maintained in clean and serviceable condition. The accuracy of the weight batcher shall be periodically checked. Both mixer and the weight batcher shall be set up level on firm base and the hopper shall be loaded evenly. The needle shall be adjusted to zero when the hopper is empty. Fine and coarse aggregates shall be weighed separately.

4. Each time the work stops, the mixer shall be cleaned out and the next commencing he mixing, the first batch shall have 10% additional cement to allow for striking in the drum.

C. BATCHING AGGREGATE BY VOLUME

1. Obtain approval before using this method.

2. Batch cement by weight and water by either weight or volume.

3. Measure aggregate in metal container whose depth is not less than their greater width and the size of which is such as to enable the whole to be easily checked.

4. Concrete shall be mixed in concrete mixers until a uniform distribution of the material, and a uniform colour and consistency is obtained.

5. Concrete mixing shall in no case be less than two minutes.

6. Each batch shall be so charged into the mixer that approximately 10% of the water enters the drum before the cement and aggregate. Water shall be added gradually while the drum is in motion, so that all the water is in the drum until the first quarter of the minimum time.

7. The amount of concrete mixed in drum shall not exceed the rated capacity of the mixer and the whole of the material shall be removed before a fresh batch enters the drum.

8. Do not modify the mixed concrete either by addition of water or cement or other means.

3.7 CLEANLINESS

1. Clean mixer and handling plant by washing with clean water at the end of the work and at intervals of 30 minutes during mixing.

2. If old concrete mix remains in the mixer drum, rotate the drum with clean aggregate and water before mixing the cement.

3.8 PLANNING OF CONCRETE

1. Consultant shall be informed 24 hrs in advance before the pour of each concrete to allow for inspection of reinforcement, sizes and levels of the members to be concreted, concrete cover, cleanliness, filling of gaps and wide and supporting props.

2. Ensure that the spaces to revive concrete are clear free from debris and free from water.

3. Transportation: Use approved method to identify that the grade of concrete to be placed in proposed location.

4. Use suitable stools, walkways, barrow runs, for traffic over reinforcement or freshly placed concrete.

5. Clean the transportation equipment immediately after use or whenever cement and aggregate is used by using clean water.

Following issues are to be noted while planning of concrete pours:

1. Slabs: to be cast in strips and not in alternate bays.

2. Walls: to be cast in successive pours working away in both directions from the center with not shrinkage gaps except for final closure.

3. Starters: shall be the same as for the main member and shall be vibrated / rammed into place and prepared as for other joints. Starters to be cast for walls monolithically with foundation. In case of columns, they can be cast after concreting of foundation / slab.

3.9 ORDINARY CONCRETE (PLAIN CEMENT CONCRETE)

1. Ordinary cement concrete where specified shall be used

2. Proportions 1:3:6, 1:2:4, 1:1.5:3, etc., in the specification refers to the quantity of cement by volume, dry coarse sand by volume, quantity of coarse aggregate by volume.

3. Cement shall be weighed based on 1 cum. of cement weighs 1440 kgs or 1 full bag of cement 50 kgs corresponding to 35 lts. by volume.

4. Correction factors to be applied for bulking of sand when the sand is either wet or moist.

5. Water cement ratio used shall be just sufficient for the workability of concrete.

6. Minimum strength of concrete shall be obtained as below:

Sl No	Proportion of concrete	Preliminary tests	Work tests
1.	1:3:6	135 kg/sq.cm.	100 kg/sq.cm.
2.	1:2:4	200 kg/sq.cm.	150 kg/sq.cm.
3.	1:1½:3	265 kg/sq.cm.	200 kg/sq.cm.

Comprehensive strength of concrete shall be obtained by testing 15 cm. cubes at 28 days curing.

1. Testing: 6 cubes shall be taken from any mix, 3 of them to be tested at 7 days, 3 at 28 days.

2. Strength of concrete at 7 days shall be 2/3rds of the strength of concrete at 28 days.

3. Strength of concrete at 28 days shall be as mentioned in table above and the criteria for accepting concrete are only the strength of concrete at 28 days.

3.10 REINFORCED CEMENT CONCRETE

RCC comprises of formwork, reinforcement and concrete. Payment of Reinforced Cement Concrete shall be item wise as specified in the BOQ. Concrete shall be classified by its compressive strength at the 28th day. The concrete grade shall be as designated in Table 2 of IS: 456-2000.

Bill of Quantities shall specify various types of concrete aimed to be used in the Project. It shall be the Contractor's responsibility to carry out Design mixes and approval of the same from the Developers Representative well in advance of the actual pouring of concrete at the Site in the permanent works.

The basic aim of Mix Design shall be to find the most economic proportion of cement, aggregate and water which will give the desired target mean strength of concrete, workability and durability for specified grade of concrete. Also it is important that the Mix should be easily worked with the help of equipment available at the Site. The operations involved are measurement of materials, their mixing, placing, compacting, finishing required and curing. The design shall be carried out strictly to IS Specifications and IS Codes of Practice, namely IS: 456-2000 and S P –23-1982.

In order to ensure that not more than the specified proportions of test results are likely to fall below the characteristic strength, the concrete mix has to be designed for higher average compressive strength for a specified grade of concrete is defined a target mean strength.

3.10.1 DESIGN MIX AND TRIAL MIXES

Design Mix and weigh batching will be done as approved by the Architect/ Client. The Contractor shall submit to the Architect/ Client the tentative Mix Design it proposes to use at the site.

On receipt of the above, the Architect/ Client may immediately order to carry out work or site test before the final approval. This shall be done with the mixer, weigh batches, etc. and materials actually used in the Project.

This shall give the Contractor additional chance to check for itself actual workability and make sure that the mix proposed by it will be satisfactory with regards to slump, water-cement ratio and workability.

Test cubes shall be of size 150mm x 150mm x 150mm. These are to be legibly marked with location and date of concreting. Where concrete (in works) is to be vibrated or not vibrated, the cubes are to be cast as per IS Standards.

Where the concrete in the works is un-compacted, pour the concrete into the mould in three layers and compact each layer with a 16mm dia tamping rod. Six (6) cubes shall be taken from each of the three

batches to test the mix. Cube shall be cast, stored, cured, transported and tested as per IS:516-1959. The test may be carried out at the Site or at laboratory as approved by the Architect/ Client.

TRIAL MIX

Within 7 days of signing the contract and before commencing work on site, prepare trial mixes for each type of concrete and submit 6 preliminary test cubes from each mix to the testing authority

The testing authority shall test three test cubes at 7 days and three at 28 days for each type of mix where the difference between the higher and the lowest test results from any one trial mix at 7 days exceeds 15% of the average and any cube weaker than the minimum requirement, make a further trial mix, increasing the proportion of cement if necessary to obtain the required strength. If any test results from any one-trail mix fail to exceed the minimum strength at 28 days: Remove from site materials from which the trial mix was prepared. Provide new materials and prepare and test further trial mixes until specified requirements are achieved. The Design Mix shall hold good so long as the materials continue to be of the same quality and from the same source. Minor adjustments are to be done daily based on the tests of materials used.

Compression strength on 150mm Cubes

Grade of concrete at 28 days	**Preliminary test minimum kg/sq.cm**	**Work test minimum kg/sq.cm.**
(1)	(2)	(3)
M10	135	100
M15	200	150
M20	260	200
M25	320	250
M30	380	300
M35	440	350
M40	500	400

Control concrete shall be proportioned to obtain the required strength by conducting lab tests using the coarse aggregate, sand and cement based on the design mix. Control concrete shall have suitable workability for proper consolidation.

At places having heavy reinforcement when compacting concrete is a problem, the control concrete shall be designed with special care to the required strength and workability at no extra cost.

Testing facilities to access the moisture content of aggregate at frequent intervals, testing of concrete cubes and testing of aggregate shall be done at the site by establishing testing laboratories.
Concrete shall be weighed batched. The dials of weigh-batching units shall be checked with standard weights periodically.

Under special circumstances the conversion of weights to volumes will be allowed by the Consultants / Architect/ Client.
The minimum cement content to be used for the job is as follows:

53 GRADE
M 20 300 Kg/cum
M 25 350 Kg/cum
M 30 380 Kg/cum
M 40 460 Kg/cum
Note: These are minimum quantity of cement to be used irrespective of the design mix.

Further the Contractor has to provide and maintain all the equipment and stock at the Site throughout to carry out the following tests in a small site laboratory or get these tests done from approved laboratories without extra cost to the Contract:

1. Grading of aggregate
2. Silt content of sand
3. Moisture content of aggregate
4. Slump test of concrete mix
5. Concrete cube test

The Contractor shall maintain full records for all above tests in a register. The format of the records shall be prepared in consultation with the Architect/ PMC/Engineer. It shall have full access to the Contractor's site laboratory. The Contractor shall include charges for these in its rates and no extra whatsoever shall be payable on this account of designing, testing, maintaining laboratory, etc.

3.10.2 ASSUMED STANDARD DEVIATION

Where sufficient test results for a particular grade of concrete are not available, the value of standard deviation given in Table below may be assumed.

Grade of Concrete	Assumed Standard Deviation N/Sq.mm
M 10	2.3
M 15	3.5
M 20	4.6
M 25	5.3
M 30	6.0
M 35	6.3
M 40	6.6

However, when adequate post records for a similar grade exists and justify to the designer a value of standard deviation different from the shown in table above, it shall be permissible to use that value.

3.10.3 STANDARD DEVIATION BASED ON TEST RESULTS

1. Number of test results - Total number of test results required to constitute an acceptable record for calculation of standard deviation shall be not less than 30. Attempts should be made to obtain the 30 test results, as early as possible, when a mix is used for the first time.

2. Standard deviation to be brought up to date - the calculation of the standard deviation shall be brought up to date after every change of mix design and at least once a month.

3.10.4 DETERMINATION OF STANDARD DEVIATION

1. Concrete of each grade shall be analyzed separately to determine its standard deviation.

2. The standard deviation of concrete to a given grade shall be calculated using the following formula from the results of individual tests of concrete of that grade obtained as specified for test strength of sample.

3. Estimated standard deviation S=Square root of (sum of squared deviations of the individual strength of n samples divided by n-1) where n = number of sample test results.

4. When significant changes are made in the production of concrete batches (for example changes in the materials used. mix design, equipment of technical control), the standard deviation value shall be separately calculated for such batches of concrete.

3.10.5 MIXING OF CONCRETE

Weigh Batching shall be followed if mixed at the site for all structural concrete works. The Contractor shall provide Concrete Batch Mixers, Vibrators, Weigh Batchers conforming to relevant IS Specifications and from approved and recognised manufacturers. The capacity and number of mixers and vibrators required at the Site from time to time shall be to the approval of Architect/ Client. No equipment from the site shall be removed without the prior written approval of the Architect/ Client. The Contractor shall maintain a platform weighing scale of capacity 300 kg with fraction of 100 gm at the site.

The machine will have to be got calibrated by the Contractor once in every two weeks or after 200 cum of concrete whichever is earlier, and records of these calibrations shall be maintained. The dials of the weigh batchers shall be checked with standard weights periodically.

3.10.6 CONSISTENCY

The concrete which will flow freely into the forms and around the reinforcement without any segregation of coarse aggregates shall be used. The consistency shall depend upon the type of vibrator etc. to be used. The controlling factor for the same is the Slump Test.

When considered necessary by the Architect/ Client, the workability of the concrete shall be ascertained by compacting factor test and VEE BEE consistometer method as per IS:1199-1959. The computing of values of workability of concrete by above two methods, IS:456-2000 have to be referred to.

3.10.7 TEMPERATURE OF CONCRETE

The placing temperature of concrete shall not be more than 38 degrees Celsius. If it is more, the Architect/ Client may order addition of ice or chilled water to the concrete. Also the Contractor shall take following precautions:

1. Mixer and Weigh Batcher shall be painted white color.
2. Aggregate storing bin shall not be exposed to the sun.
3. Water shall be sprinkled on aggregate well before concreting to keep the temperature low.

Similarly, during the cold weather, concreting shall not be done when the temperature falls below 4.5 Degrees Celsius. The concrete placed shall be protected against by suitable covering. The concrete damaged by frost shall be removed and work redone with no extra cost.

3.10.8 SHRINKAGE CRACKS

Concreting shall be avoided in very warm weather. Under such circumstances, the placed concrete shall be covered with damp Hessian cloth within two hours of placing of concrete.

To achieve good result the concrete shall be immediately covered with a plastic sheet and not allowed to any direct wind contact to eliminate shrinkage cracks.

3.10.9 WORKMANSHIP

All works shall be true to level, plumb and square and all corners and edges in all cases shall be unbroken and neat. Any work not to the satisfaction of the Architect/ Client or the Design Consultant will be rejected and the same should be rectified or removed and replaced with work of the required standard of workmanship at no extra cost.

3.10.10 TRANSPORTATION

Concrete shall be transported with the help of pumps of sufficient capacity to achieve necessary heights wherever required from the mixer to the place of laying as rapidly as possible by methods which will prevent the segregation or loss of any of the ingredients and maintaining the required workability. The pumps can be either compressor type or boom type. All the pumping equipments have to be maintained and kept operational by the contractor.

3.10.11 PLACING OF CONCRETE

Placing of concrete shall be done using pumps only at all levels. The pumps shall be of sufficient capacity to achieve necessary heights wherever required.

The slump of concrete placed with the help of pumps shall not be more than 100mm unless otherwise instructed by the Architect/ Client. Concreting shall commence only after formwork is approved reinforcement is recorded and permission to proceed with concreting has been approved in writing from the Architect/ Client.

Formwork should be clean, free from dust, pieces of wood or any other foreign material. It should be treated by form releasing agent prior to the laying of reinforcement and concrete, based on sample approved by the Architect/ Client prior to start of construction at Site. Concrete shall be as gently deposited as is practically possible, in its final position to avoid rehandling and shall be so deposited that segregation of aggregates do not occur. In case of deep trenches and footings, it may be done with the help of chutes. Concrete from wheelbarrows shall not be dumped away from the face of concrete already been placed. It shall be dumped into the face of concrete already in place. Concrete shall be laid during normal working hours. Concreting at night or on holidays shall be permitted only on the written approval of the Architect/ Client. No concreting shall be done within half an hour of the closing time of the day, unless permitted by the Architect/ Client.

For concreting of slabs and beams wooden plant or catwalks of chequered MS plates or bamboo mats or any other suitable materials supported directly on the centering by means of wooden blocks or lugs shall be provided to convey the concrete to the place of final deposition without disturbing the reinforcement in anyway. In no case labour or any other persons are allowed to walk over the reinforcement.

In case of columns and walls, it is desirable to place concrete without any construction joints. The progress of concreting in the vertical direction, shall be restricted to one meter per hour.

3.10.12 COMPACTION OF CONCRETE

Concrete shall be thoroughly compacted into a dense mass as depositing shall proceed by means of suitable vibrators. The vibrator shall maintain the entire concrete under treatment in an adequate state of agitation and shall continue during whole period occupied by placing of concrete. Care should be taken not to over-vibrate the concrete. While vibrating no holes should be visible in concreting. Compaction should be completed before the initial setting time. Compaction shall be done till air bubbles cease to appear. Concrete already set shall not be disturbed by successive vibration.

Hand tamping shall not be permitted. But only in exceptional cases, depending on the thickness of the members and feasibility of vibrating the same, the Architect/ Client may permit hand tamping. Hand tamping or compaction shall be done with the help of tamping rods so that concrete is thoroughly

compacted and completely worked around the reinforcement embedded fixtures, and into the corners of the form look. The layers of concrete shall be so placed that the bottom layer does not finally set before the top layers are placed. The vibrators are so applied so that the centre of mass being compacted at the time of placing of concrete.

Vibrator shall be of immersion type with frequency of 100 Hz minimum when operating in concrete, or the exterior with a frequency of 50 Hz minimum. Care shall be taken to ensure that at no time the vibrators and /or vibration action is used to push the concrete ahead. Vibrators shall be applied systematically to overlap zones of influence. It shall be ensured that the needle vibrators are not applied directly on the reinforcement on the formwork which may destroy the bond between concrete and reinforcement. When electric vibrators are in use the standby petrol, diesel or kerosene vibrator should always be available at the concreting point.

3.10.13 CONSTRUCTION JOINTS

Construction joint shall be avoided as far as possible. If provided, concreting shall be carried out continuously up to the construction joints as directed by the Architect/ Client and/or at the location and arrangement shown in the structural drawings. However, the number of such joints shall be kept to a minimum and they shall be as straight as possible.

Proposed location of construction joints shall be submitted by the Contractor well in advance for approval of Architect/ Client/ Structural Consultant. The joints shall be at places where shear force is nil or at a minimum (normally at 1/3rd to 1/4th point of a span) and these shall be straight and at right angles to the direction of the main reinforcement. Stop ends provided shall be with necessary slots for reinforcement bars to pass freely without bending or other obstructions. They should be supported firmly so that the concrete can be properly vibrated and compacted at these points.

Before commencement of concreting after a break, adjacent concrete stopper and surfaces shall be cleaned, chipped free of any loose mortar and roughened to expose the aggregate and than brushed and cleaned. The concrete surface shall be sprayed with water for 24 hours before casting and kept wet until casting.

1. HORIZONTAL JOINTS IN WALLS

Form horizontal joints in walls designed to be continuous with floor slabs at the top of an integrally cast kickers minimum 25mm high. No other horizontal joints will be allowed.

2. FORM HORIZONTAL JOINTS IN WALLS OTHER THAN IN (1) ABOVE

   a) At the top of footings
   b) At the top of slabs
   c) At a minimum 20mm above the soffit of beam or girders connecting into columns.
   d) 15mm above soffit of suspended floors.

3. CONSTRUCTION JOINTS IN GROUND SLABS

   a) To comply with IS codes
   b) To align with column or grid lines where practicable.

4. ISOLATION JOINTS

   a) Form diamond shaped or circular separations around columns.
   b) Ensure all edges of slabs are isolated from adjoining construction.

5. CONTROL JOINTS

a) Space at 4 - 7 meter in width for one panel.
b) Form by either:
   1. Sawing a continuous straight line in the top of the slab
   2. Grooving fresh concrete with hand grooves
   3. Placing strips of wood, metal or pre-moulded joint material at joint locations. Top edges of strips shall be flush with concrete.
   4. Control joints shall be extended 1/5 to 1/4 times slab thickness into the slab.

6. CONSTRUCTION JOINTS IN SUSPENDED SLABS

c) Locate near the middle of slabs, beams, or girders, unless a beam intersects a girder at the middle location, in which case offset joints in girders a distance equal to twice the width of the beam.
d) Make provision for transfer of shear and other forces through construction joints.

7. VERTICAL JOINTS IN WALLS

Space not exceeding 5m center to centre; also locate where abrupt changes in thickness or height occur, at least 2m from corner.

3.10.14 EXPANSION JOINT

As indicated in drawing or as directed by the Structural Consultant / Architect/ Client.

3.10.15 CURING

Curing of concrete is most important. There shall be no compromise on this activity as it is for the Contractor to arrange for everything necessary to make sure that the concrete is cured to the complete satisfaction of the Architect/ Client. As said above after concrete has begun to harden, i.e. about 1 to 2 hours after laying. It shall be protected from quick drying with moist or damp hessian cloth or any other material approved by the Architect/ Client. After 24 hours of laying of concrete, the surface shall be cured by flooding with water or covering with moist hessian cloth for period of 7 days to keep it moist. For the next seven days surface shall be kept wet all the time by sprinkling water continuously.

In order to properly monitor the curing activity, the Contractor shall write legibly with paint, the date of casting the concrete of each member of the structure which shall remain clearly visible at least till the completion of curing at least.

3.10.16 FINISHING

Concrete surface shall be finished keeping in mind the next operation to be carried out over the surface. For guidance the following points shall be noted:

1. Roof shall be troweled even and smooth with a wooden float, before the concrete begins to set.
2. Surface that will receive plaster shall be roughened immediately.
3. Surfaces that will be in contact with masonry shall be roughened immediately
4. Surfaces that will receive floor finishes, tiling, etc. shall be roughened while it is still green.
5. Every care shall be taken not to disturb the freshly laid concrete.
6. For Ramps and Basements
7. Concrete shall be broom-finished.

On finishing standards and quality/ workmanship, the decision of the Architect/ Client shall be final and binding on all parties.

3.10.17 INSPECTION AND CORRECTIVE MEASURES

Immediately on removal of formwork, the RCC surface shall be examined by the Architect/ Client. Till such time, no remedial measures shall be carried out by the Contractor. All remedial actions including breaking, if any, shall be on the instructions of the Architect/ Client. In case of any violation of this rule, the concrete poured stands rejected. The decision of the Architect/ Client in this regard shall be final and binding to all parties.

Sagged, bulged, patched, honeycombed work to an extent detrimental to structural safety or architectural concept shall stand to be rejected and Contractor shall rectify by breaking or redoing, if required, as directed by the Architect/ Client/ Structural Consultant and all expenses incurred due to this shall be to the Contractor's account.

Surface defects minor in nature may be accepted as a special case by the Architect/ Client/Structural Consultants whose decision in this matter is final and binding on the Contractor. Once accepted, the defects shall be rectified as follows and all expenses incurred due to the rectification process, shall be to the Contractor's account.

1. Surface defects which require repair when forms are removed, usually consist of bulges due to the movement of forms, ridges at form joint, honey combed areas, damage, resulting from the stripping of forms and bolt holes, bulges and ridges are removed by careful chipping or tooling and the surface is then rubbed with a grinding stone. Honey combed and other defective areas must be clipped out, the edges being cut as straight as possible and perpendicularly to the surface, or preferably slightly undercut to provide a key at the edge of the patch.

2. If permitted in writing by the Developer' Representative/ Structural Consultant, shallow patches are first to be treated with a coat of thin grout composed of one part of cement and one part of fine sand added with polymer modified cementitious material as per manufacturer's specification, and then filled with mortar (mixed with non-shrink additives) similar to that used in concrete. The mortar is placed in layers not more than 10 mm thick and each layer is given scratch finish to secure a bond with the succeeding layer. The laid layer is finished to match with the surrounding concrete by floating, rubbing or tooling on formed surfaces by pressing the form material against the patch while the mortar is still plastic.

3. Or as an alternative to para 2 above, as directed by the Architect/ Client/ Structural Consultant, the patch-work shall be treated with epoxy based proprietary items like non-shrinking grouts etc. available in the market. In such cases, the methodology as indicated by the manufacturer of the item shall be followed. It permitted in writing by the Architect/ Client/ Structural Consultant.

4. Large and deep patches require filling up with concrete held in place with try forms. Such patches are reinforced and carefully drawled to the hardened concrete.

5. Or as an alternative to para 4 above, epoxy based proprietary items like grouts as directed by the Architect/ Client/ Structural Consultants, shall be used. The methodology as specified by the manufacturers of the proprietary item shall be strictly adhered to.

6. Holes left by bolts are to be filled with non-shrink grouts, as specified and directed by the Architect/ Client/ Structural Consultants carefully packed in to places in small amounts. The mortar is mixed as dry as possible to allow enough water to go into it, so that it will be tightly compacted when forced into the place.

7. Tiered holes extending right through the concrete may be filled with mortar or non-shrink grout, as the case may be, a pressure gun similar to the gun used for greasing motorcars.

8. Normally, patches appear darker than the surrounding concrete when uniform surface colour is important, this defect shall be remedied by adding 10 to 20 percent of while Portland cement to the patching mortar, the actual quantity being determined by trial.

9. The same amount of care shall be taken to avoid the material in the patches as with the whole structure. Curing shall be started immediately after packing is done to prevent early drying. A membrane curing compound is these cases will be most convenient.

3.10.18 CRACKS

Cracks observed shall be examined. It shall be kept under observation and a record shall be maintained for a period of 45 days. It shall be shown to the Architect/ Client/ the Structural Consultant and the following procedure shall be followed:

1. Cracks not propagating/developing further and according to the Structural Consultant not detrimental to the strength of the construction shall be grouted with non-shrinking epoxy based cement slurry or as directed by the Architect/ Client/ Structural Consultant.

2. Cracks developing further and felt detrimental to the strength of construction shall be tested as per the relevant Indian Standards.

3. Based on results, the structural consultant in consultation with the Architect/ Client shall order remedial measures or order the contractor to dismantle construction, cart away the debris, replace the construction and carry out all the consequent works thereto as directed/ specified.

4. Cost of above shall be borne by the contractor if the failure is on its part unless it is due to a design fault, decided at the discretion of the Architect/ Client.

Decision of the Architect/ Client in the matter shall be final and binding on all parties. This decision shall not be open for arbitration.

3.10.19 QUANTUM OF CUBE TESTING

The minimum frequency of cube testing shall be as follows. Each set of sample shall consist of 6 cubes.

Concrete Quantity	**Number of Sample sets**
Up to 5 cum a day	1
5 cum to 15 cum a day	2
15 cum to 30 cum a day	3
30 cum to 50 cum a day	4
More than 50 cum per day	4 + one additional for each 50 cum or part thereof.

Three cubes shall be tested on the 7th day and three cubes on the 28th day.

3.10.20 ACCEPTANCE OF WORK

It shall be in accordance with in IS: 456-2000, SP-23 and SP-24. The guidance brief is elaborated below. Part or element of work shall be deemed to be accepted, provided the results of the 28th day cube testing confirm to the criteria stated as under:

1. The average of the three consecutive cubes strength shall not be less than specified strength.

2. No individual cube strength shall be less than 90% of the specified strength.

3. If the individual cube strength exhibit more than 133% of the specified strength such a cube shall be specified as freak and the criteria in above two points shall be applied to remaining two cubes and their acceptability determined.
4. If cubes fail at 7 days, defective concrete can be dismantled, removed and replaced without awaiting 28 day test results.

5. If the concrete tests fail to meet the acceptance strength required for respective grades of concrete, the Architect/ Client may take one of the following actions:

6. Instruct Contractor to carry out such additional tests (e.g. Core tests, load tests, ultrasound, etc.) and/or remedial measures to ensure the soundness of the structure at the Contractor's expense.

7. The work will be rejected and any consequential action as needed shall be taken at the Contractor's expense, including cutting out and replacing a part or whole of work.

3.11. READY MIX CONCRETE

3.11.1 GRADES AND STRENGTH REQUIREMENTS OF CONCRETE

1. GENERAL

Ready mix Concrete shall consist of the material described under site batched concrete sections, using separate coarse and fine aggregate in an appropriate combination determined in the course of the of mix design . The overall grading shall be such as to produce concrete of the specified quality which will work readily in to position without segregation. The ready mix concrete shall conform to IS:4926 and shall be delivered in agitating trucks. The RMC may contain fly ash as per the acceptable norms. (Maximum 20% to 22% of cement content)

2. SLUMP

The water shall be added to the cement and aggregate during mixing to produce concrete having a sufficient workability to enable it to be well consolidated, to be worked in to the corners of the shuttering and around the reinforcement to give the specified surface finish, and to have the specified strength. Water cement ratio shall be maintained as per IS. 456-1978 when a suitable amount of water has been determined, the resulting consistency shall be maintained through out the corresponding parts of the work and tests shall be conducted to ensure the maintenance of this consistency. The max slump at the point of the discharge should not exceed 110mm max.

3.CONCRETE GRADES

Grade of concrete used in the works shall be shown on the drawings or as directed by the Architect/PMC/ ENGINEER-IN- CHARGE. The minimum cement used for M-20 shall be 300 Kg. Per Cum, 350 Kgs for M-25 and 380 Kgs for M-30, 425Kgs for M-35, 460 Kgs for M-40. The mentioned quantity of cement indicates cementious material i.e., cement including fly ash.

3.11.2 TRANSPORTING CONCRETE

Concrete shall be transported in agitating trucks without contamination, loss of ingredients or segregation. In no case shall a period of more than 4 hours have elapse between the wetting of mix and discharge of the concrete at site. The RMC vehicle should carry a computer-generated slip showing weight of all the ingredients including cement used and time of mixing.

3.11.3 CONCRETE PLACEMENT

1. GENERAL

Concrete, when deposited, shall have a temperature of not less than 5oC (41oF) and not more than 32oC (90oF).

The concrete shall be placed in the positions and sequences indicated on the drawings, in this specification and/or as directed by the Architect/PMC/ engineer-in- charge. Contractor shall give adequate notice to the Architect/PMC/ engineer-in- charge of his intention to concrete any section of the works.

Except where otherwise directed, concrete shall not be placed unless the representative of the Architect/PMC/ engineer-in- charge is present and has previously examined and approved the positioning, fixing and condition of the reinforcement or any other items to be embedded and the cleanliness, positioning and suitability of the concreting surface.

The concrete shall be deposited as nearly as possible in its final position. It shall be placed in such a manner as to avoid segregation of the concrete and displacement of the reinforcement, other embedded items, or formwork. It shall be brought up in horizontal layers not exceeding 450 mm in compacted thickness unless otherwise authorized or directed by Architect/PMC/ engineer-in- charge. Concrete shall not be placed simultaneously on each side of large horizontal specified or approved construction joints.

Shutters for walls or thin sections of considerable height shall be provided with openings or other devices that will facilitate the cleaning of the accumulation of hardened concrete on the shutters or on the metal reinforcement above the level of the concrete and the removal of concrete in the case of segregation's.

2. PLACING CONCRETE IN COLD WEATHER

No concrete shall be mixed or placed while the ambient temperature is above 40 degree C. on a rising thermometer or below 4 degree C. on a falling thermometer. The contractor shall supply an accurate maximum and minimum thermometer and hang it in an approved position on the works. Aggregates that have been exposed to frost shall not be used until completely thawed. Concrete shall be maintained by approved means at a temperature of not less than 4 degree C. during placing, and for a period of three days thereafter. All concrete placed during cold weather or when a frost is predicated or is likely to occur or occurs contrary to expectation, shall be protected from freezing by approved means.

3. PLACING OF CONCRETE IN WET WEATHER

Concrete shall not be mixed and or placed in rainy weather or when there is likelihood of impending heavy showers. If it becomes necessary to place concrete during rainy weather, the contractor shall provide adequate protection by means of tarpaulin or similar other water proof material to immediately cover fresh concrete to prevent rain falling over it. This protection shall be left on the concrete for a period of 24 hours after placing of concrete.

3.11.4 CONCRETE PLACEMENT UNDER WATER

Concrete placed under water shall be deposited through a tremmie pipe the diameter of which shall be at least 8 times the size of the largest aggregate used in the concrete mix.

The construction of and the method of handling the tremmie pipes shall be approved by the Architect/PMC/ Engineer-in-charge. The pipes shall be waterproof and sufficiently strong to withstand severe handling conditions and any joints must be sealed with adequate gaskets.

At the commencement of tremmie work the bottom of the pipe shall be sealed before being lowered in to position. The seal shall only be broken by the concrete being placed. The concrete placed in contact with a horizontal construction joint shall have a lower proportion of coarse aggregate and a higher proportion of cement than the remainder of the concrete. The proportion shall be agreed with the Architect/PMC/ engineer-in- charges' Representative.
All underwater concrete shall be placed in still water within a cofferdam or formwork which shall extend above water level.

The proportions of the mixes shall be agreed in accordance with the strength and workability required by the specification. To allow for losses an addition of 10% of cement shall be added to mixes of concrete scheduled to be placed under water.

3.11.5 QUALITY CONTROL

1. In order to ensure that the quality of materials and the mix proportions are suitable for the particular grade of concrete required are so maintained, sampling and testing shall be carried out regularly during the course or the works.

2. Workability testing shall be carried out in accordance with IS:456. The results shall lie within the range upon which the accepted mix design is based. Testing shall be carried out at such a frequency that the required workability is consistently achieved.

3. Samples of concrete shall be taken at random in accordance with IS: 516 at the time and place of deposition of the concrete at a frequency of sampling for each grade of concrete and from each concrete mixing plant at six cubes of 150 mm nominal size per 50 cubic metres of concrete placed in the works or twice per week.

4. Notwithstanding the foregoing, additional samples shall be taken by the contractor when directed by the Architect/PMC/ engineer-in- charge. The test cube procedure shall be in accordance with IS: 516 throughout.

5. Compliance with the specified characteristic strength shall be assumed if:

   a) Each of the six cubes in a group has a test strength not less than the characteristic strength or,

   b) Not more than one cube has a test strength less than the specified characteristic strength but not less than 85% of the specified characteristic strength and the average strength of the group of four test results is not less than the specified characteristic strength plus the standard deviation of the group.

3.11.6 SEVEN-DAY CUBE TESTS

Acceptance of concrete is based on the 28th day results. However, the contractor shall establish a relation ship between 7 days and 28 days strengths by carrying out 7 days tests at the time of performing the laboratory testing and from subsequent quality control testing. This relation ship shall be used in interpreting any further test results to predict the probable value of the corresponding 28 days cube strengths. The contractor shall without delay advise the Architect/PMC/ engineer-in- charge

of any sample that appears likely to fail to meet the specification and the contractor shall take any necessary action to minimize the effect of such failure.

3.11.7 ACCEPTANCE CRITERIA

The general Acceptance Criteria of any and all of the concrete work shall be as per the relevant Clauses of IS. 456.

If any of the works tests are not up to the standard, the Architect/PMC/ engineer-in- charge shall have the power to stop the work until the reason is investigated and steps taken to prevent further low results. The contractor shall not be entitled to any claims on account of such delays. Any concrete carried out from the batch that is afterwards found to be faulty, will be liable for rejection and if so directed, the contractor shall at his own expenses dismantle and replace the defective work and any work built thereon or shall take such other measures as may be deemed necessary by the Architect/PMC/ engineer-in- charge. At the discretion of the Architect/PMC/ engineer-in- charge, the contractor may be allowed to prove by means of a load test to be carried out at his own expense, that the concrete is capable of safely withstanding the loads as specified in the test.

3.12. VACCUM DEWATERED CONCRETING/ TREMIX FLOORING

1. PREPARATION

The surface to receive flooring shall be clean, free from dirt and free from foreign material.
Any undulations or mortar remaining on the floor shall be trimmed. Base course shall be trimmed.
The base shall be cleaned and watered before laying the floor. Work includes at all depths and heights.
The finished surface shall be kept wet for a maximum period of one week.

2. CONCRETING

General

Concreting shall have a concrete base of M15 of specified thick.
Flooring shall have hard top on the concrete base.
Flooring shall be laid in strips, the size of which is mentioned on the drawings.

Materials

Cement - Portland
Sand - River sand
Aggregate - Max. size 10 to 20mm
Water - Potable
Floor hardener (Optional) - @4.5 Kg/Sqm (for Hardener refer Clause 5.2)-
Sealant (Colpor or equivalent) - At all control joints of size 10mmx6mm at every 20 Sqm area

3. EXECUTION

Concrete shall be M 15 of specific thick. Prepared concrete shall be laid immediately after mixing. The base shall be free from water and other foreign materials, dust and dirt. A coat of cement slurry of the consistency of thick cream shall be brushed on the surface of the base course. The concrete shall then be spread over this base evenly and leveled carefully. Low areas shall be filled with concrete and humps removed. De-vaccumisation shall be done for removing the voids. The

whole concrete surface shall be leveled, compacted by ramming and trowelling. Prepared surface shall be allowed to set. Hardener screed

Hard top to be prepared as per the specifications with Nitohardner and one part of dry cement. The hard top shall be provided over concrete base immediately after it is set, compacted and leveled with a steel trowel. The surface shall be trowelled to bring the hardener coat to a leveled surface. Excessive trowelling shall be avoided. After the initial set, further compaction shall be done by steel trowelling. Final brushing shall be made before the floor top becomes too hard.

4. CURING

Curing shall commence as soon as the surface is hard enough to receive the water.

The surface shall be covered with sacks or sand and shall be kept continuously wet for a period of at least one week.

4. FORMWORK

4.1. SCOPE OF WORK

The work covered by this section of the specifications, consists of furnishing all plant, labour, equipment, appliances and materials and in performing all operations in connection with the supply and installation of form work for concreting, complete in strict accordance with this section of the specifications and subject to the terms and conditions of the Contract.

4.2. GENERAL CONSIDERATIONS

It shall be the responsibility of the Contractor to perform the work by well trained and experienced staff or by the Sub- Contractor who shall have enough number of well trained and experienced staff and coordinate with the other operations. However the Contractor shall be responsible for the quality of work performed by the Sub-Contractor as per the requirements of these specifications.

4.3. APPLICABLE CODES

IS - 303 Specification for Plywood for general purposes
IS - 4990 Specification for plywood for concrete shuttering work
IS - 1629 Rules for grading of cut size of timber
IS - 2750 Specification for steel scaffoldings.
IS - 4014Code of practice for steel tubular, scaffolding

4.4. MATERIAL SPECIFICATIONS

The Contractor shall use the following Form work materials for different purposes as stated below:

1. Timber.
   - Form framing, sheathing, and shoring.

2. Plywood.
   - From sheathing and panels.

3. Steel.
   - Heavy forms and falsework.
   - Column and joint forms
   - Permanent forms
   - Welding of Permanent forms.

4. Form Ties Anchors, and Hangers- For securing formwork against placing loads and pressures.

5. Coatings. - To Facilitate form removal.

6. Steel Joists. - For Form work support.

7. Steel Frame Shoring - For Form work support.

Construction formwork with smooth faced plywood, steel or timber to produce smooth straight level and sharp profiles shall be used for the works. Panels to be in largest practicable sizes to reduce the number of joints. Form material shall have strength adequate to withstand pressure of newly placed concrete without excessive and adjustable bow or deflection.

Factory fabricated adjustable length removable or snaps of metal form ties, design to prevent from deflection and to prevent spilling concrete surfaces on removal.

Ties shall be such that:

a) A portion remaining within the concrete shall be at least 38mm from the outer concrete surface.

b) That will not leave a hole larger than 25mm die meter on the concrete surface.

Form coating compound that will not bond with, stain, not adversely effect concrete for required bond or adhesion not hamper the wetting of surface to be covered with water or curing compound.

All propping and centering shall be of adjustable steel supports (built-up sections of rolled steel) and tubular props to full height without joints, and with sufficient bracing to take into account the construction loads, namely full load of concrete with any live load and impact load likely to occur during concreting.

Steel shuttering used for concreting shall be sufficiently stiffened. The steel shuttering shall also be properly repaired before sue and properly cleaned to avoid stains and defects in concreting.

4.5. DESIGN CRITERIA

1. Formwork system shall be executed and designed by a specialist qualified to the shapes, lines, forms and dimensions shown on drawings. The Contractor shall submit to the Architect/ Client a method statement backed by design calculations. Required drawings and sketches shall be enclosed along with the statement for the proposed area to be taken up for working at a time. The number of repetitions expected, type of material used, etc shall be detailed therein.

2. Formwork shall start only after written approval from the Architect/ Client & Structural Consultant has been received. Approval of the proposal in submitted form a acceptance of modification does not relieve the Contractor of its obligation to achieve its required line finish within accepted tolerance limits in terms of quality of works completed and safety. Neither will it diminish the Contractor's responsibility for the satisfactory performance of formwork. Basic points to be understood in designing of formwork are stated below:

   a) Erected Formwork shall be watertight, shall conform to shape, lines, dimensions, verticality, rigid during placing, vibrating and configuring the concrete.
   b) Formwork system shall be of steel or timber or 12mm thick water resistant Ply board, and shall be continuous, straight and without any warping.

3. Design of formwork shall take into account:

a) Height of pour
b) Thickness of member
c) Rate of pour
d) Concrete slump
e) Texture of finish
f) Placing temperature
g) Concrete density
h) Construction joints
i) Wind load
j) Method of Discharge
k) Form work design shall have
l) Dimensional tolerance
m) De mountable without shock, disturbance or damage to concrete
n) All construction joints in beams and slabs shall be provided as shown in drawings.
o) Ties shall be provided where required
p) Cambers shall be provided where shown.
q) Props / supports of extra ceiling height shall be specially designed.

4.6. WORKMANSHIP

1. Formwork shall be classified based on the ultimate finishes required of the concrete surface as

   a) Textured or decorative finish
   b) Fair-faced finish
   c) Rough finish

2. The Contractor shall account for all material and labour to achieve the above finishes to the satisfaction of the Architect/ Client in his quoted price.

3. Guidelines for Good Workmanship

Following are a few points as guidelines for good workmanship in formwork and shall be accounted for in the contractor's quoted price:

1. Erection of formwork may be from pre-moulded, pre-fabricated, pre-assembled plates or form reasonable enough to transport and erect at site to correct lines and levels as set at site.

2. Supports shall be firm and maintained in position by nails, cross bracing, tie-rods, locking bolts, nuts, etc. It shall be rigid and stiff so as to retain its shape during and after concreting.

3. Joints shall be water-tight and no cement slurry shall be allowed to get through

4. Pre-fabricated or site forms shall be assembled so as to deshutter without any jerk to the green concrete. For this double wedges shall be used. The wedges shall be nailed. The heads left with, allowing easy removal while deshuttering.

5. Pre-fabricated or site formwork shall be sufficient thickness with supporting spans in both directions. These shall be standardised in size for easy replacement and universal use at site

6. Props shall be of steel only. Its spacing shall be as per design. It shall be vertical and plumbed. Base shall be of proper steel plate or timber plank for equal distribution of load

7. In case of multi-storied buildings, any upper floor shall be suitably supported on at least one floor below the same, or as approved by the Architect/ Client.

8. Props shall be adequately cross-braced horizontally

9. At the design and erection stage following additional points shall be considered and be incorporated into the setting

10. Cleaning of Opening prior to the start of concreting

11. Pouring points shall avoid high drops and provide easy access to vibrating needles

12. Surfaces shall be treated with suitable releasing oil or emulsion prior to the reinforcement laying. Such releasing oil shall be got approved from the Architect/ Client.

13. Ensure that forms and adjacent surfaces are thoroughly cleaned to receive concrete and debris.

14. Locate construction joints in a manner so as not to impair strength and appearance of structure.

15. Without absolving the details on the above, the Contractor shall comply with instruction of the Architect/ Client regarding formwork designing, erection, execution, rotation, maintenance and reuse.

16. Following points shall be observed very carefully:

    a) Joints of formwork shall be watertight. It is easy to check from the bottom and make sure no light is visible

    b) Props shall be on solid base, plumbed, in straight line, braced horizontally and cross

    c) Tie-bars, bracing and spacers in beams, walls and columns shall be at correct place/location and fully tight

    d) Wedges shall be fully secured and nailed with heads left out for easy removal

    e) All saw dust, dirt, shavings and any other unwanted material shall be cleaned and hosed out

    f) Provision shall be made for watching formwork while concreting and any other platform needed for movement of workers without any disturbance to the reinforcement

    g) Provision is made for traffic on formwork: not to bear directly on reinforcing steel.

    h) Number of reuses shall be decided by the Architect/ Client on examining the condition of formwork after each use. If during concreting any weakness develops or formwork shows any distress, the work shall be stopped and remedial action taken.

17. Finishing Formed Surfaces

The Contractor shall:

    a) Repair and patch defective areas with fins and other projections completely removed or smoothed.

b) To smooth concrete where fins and other projections have formed moisten concrete surface within a day after forms have been removed and rub with carborundum brick until surface is a uniform colour and texture within the projection limits.

c) Not apply cement ground other than that produced by the rubbing process.

d) Remove and replace concrete having defective surfaces if defects cannot be repaired to the satisfaction of the superintendent.

Surface defects shall include colour and texture irregularities, cracks, spills, air bubbles, honeycombs, rock pockets, fins and other projection on the surface, stain and form tie holes.

The contractor shall:

a) Undercut voids larger than 25mm diameter and fill with fresh concrete after thoroughly wetting concrete surfaces.

b) Fill small holes and irregularities using 2:1 (Portland cement to fine sand by volume) grout mixed with approved bonding admixture according to manufacturer's specification.

c) Blend standard Portland cement with white Portland cement if necessary so that final colour of dry grout will match adjacent surfaces.

d) After applying grout to repair area, wipe with Hessian cloth to match adjacent texture and within the specified surface tolerances.

e) Keep concrete patch damp with fog *spray for at least 36 hours.

4.7. MODES OF MEASUREMENTS

Formwork shall be measured as the area (in square metres) of shuttering in contact with the concrete including covers, angles, splays, mitres, bevels, etc. for which no special rate shall be allowed.

1. It shall be measured to the nearest centimeter and the area worked out correct to two decimal places

2. No deduction shall be made for openings up to 0.4 square metre in plan

3. Area of voids shall deducted from the face area of shuttering.

4. No deductions shall be made from formwork of main beams where a secondary beam intersects it. Formwork for secondary beams shall be measured up to sides of the main beams.

5. No deduction shall be made from the formwork to column casings at intersection of beams.

6. Lapping of formwork with previously laid out concrete will not be measured and will not be paid for.

7. The quoted rate shall be applicable for all working conditions and at all heights and depths or lifts specified in the drawings. The rate shall include the cost of materials and labour for various operations involved including, but not limited to the following:

8. Provision of formwork, its erection and treatment of the concrete surface immediately after removal of the formwork

9. Holes to be made in the formwork for inserting electrical conduits, piping for plumbing works, etc

10. Centering, bracing, tightening with bolts and nuts, staging, etc.

11. Splayed edges, notching, allowance for overlaps, centering, shuttering, strutting, bolting, nailing, welding, casing striking and removal.

12. Filling to form stop chamfered edges or splayed external angles to footings, beams, columns and the like.

13. Temporary openings in the forms for pouring concrete and removing rubbish.

14. Dressing with oil/approved emulsion to prevent adhesion of concrete with shuttering.

15. Raking or cutting.

16. Fixing inserts and openings at the correct line and level and at any stage to support the same at the directed height and place.

17. Platforms if any to check forms while concreting is in progress.

18. Filling and making joints watertight to the satisfaction of the Architect/ Client.

19. Cleaning of the shuttering.

20. Cleaning the complete floor immediately on deshuttering complete to enable the start of next activity.

21. Cleaning and washing of the complete floor during and after concreting to avoid any damage to finished surface. It will be responsibility of the contractor to protect and retain all finished surfaces.

Should there be any laitance due to concreting of upper floors or other construction activities within the said floor the Contractor shall be responsible to do all that is required to bring the finish back to the original or as specified in the Technical Specification/ directed by the Architect/ Client.

No payment shall be made for temporary formwork used in concreting nor for formwork required for joints or buttheads, in floors or elsewhere whether such joints are to be covered late with concrete or mastic or other material.

4.8. TOLERANCES

Tolerance is a specified permissible variation from lines, grades or dimensions given in drawings. No tolerances are specified for horizontal or vertical encroachments beyond the legal boundaries. Unless otherwise specified, tolerances given in the following sections shall be permitted.

Tolerance for RCC Buildings - Variation from plumb should be as follows:

1. In the lines and surface of columns, walls, and other vertical members, viz inside face of lift shaft, etc. 3 mm per 3.0 metre but not exceeding 10mm for the full height of the building.

2. For exposed corner column and other conspicuous lines

In any bay up to 5 m maximum	3 mm
In 10 m or more bays	5 mm

3. Soffits of slabs, ceilings and beams

2.5 m bays	3 mm
5.0 m bays	3 mm
10.0 m or more	10 mm

4. Lintels, sills, parapets, grooves and other conspicuous lines

In any bay up to 5 m maximum	3 mm
In 10 m or more	5 mm

5. Variation of the linear building lines from established positions in plan and related position of columns, wall and partitions:

In bay up to 5 m maximum	5 mm
In 10 m or more	10 mm

6. Deviation from dimensions of footing / foundation:
   (i) Dimension in plan (+) 50mm
   (ii) Eccentricity in plan: 0.02 times the width of the footings in the direction of deviation but not more than 50mm
   (iii) Thickness: (+) 0.05 times the specified thickness.
   (iv) Surface of foundation against ground: -5mm, +10mm
   (v) Top surface of foundations, bases, piers: +5mm, -20mm

7. Variation in sizes and location of sleeves, opening in walls and floors to be 5 mm (except for anchor bolts)

8. Variation in cross-sectional dimension of columns and beams and thickness of slabs and walls -5 mm, +10 mm

Variation in steps

In a flight of stairs	Risers	Treads
In flight of stairs	3 mm	5 mm
In consecutive steps	1.5 mm	3 mm

All the tolerances mentioned above shall apply to concrete dimensions only, and not to positioning of vertical steel or dowels.

4.9. REMOVAL OF FORMWORK

Formwork shall not be struck until the concrete has reached strength at least twice the stress to which the concrete may be subjected at the time of removal of formwork.

1. Formwork shall be removed carefully without jarring the concrete and curing of the concrete shall commence immediately. Sudden shocks / vibrations during removal of wedges shall be avoided. Where finished edges have re-entrant angles, remove formwork as early as possible to avoid shrinkage cracks.

2. Concrete surfaces to be exposed shall where required by the Architect/ Client, be rubbed with carborundum stone to give a smooth and even finish.

3. Where concrete requires plastering or other finish later, the concrete surface shall be hacked as directed.

4. No extra charge will be allowed to the Contractor for such work.

4.10. MINIMUM TIME REQUIREMENTS

For other cements the stripping time shall be suitably modified in consultation with the Architect/ Client.
For precast moulds the stripping time shall be 24 hours.

Striking time shall be as follows:

	Type of Formwork	Minimum period before striking (excluding the day of)
A	Walls, columns	12 hrs
B	Vertical faces	12 hrs
C	Removal of formwork with props fully left under spanning over 6m	7 days
D	Between ribs not more than 1 to 2 m	7 days
E	Ribs, joists, beams, soffits	7 days
	Up 3m clear span – Beams	7 days
	Between 3m to 6m - Beams	14 days
	Above 6m clear span beams	21 days
F	One way floor slabs - up to 3m	7 days
G	One way floor slabs - between 3m to 6m	10 days
H	One way floor slabs - over 6m	14 days
I	Beams and Girder Sides	12 days
J	Removal of props below slabs spanning over 6m	21 days

Striking of Formwork within the time limits listed above is subject to successful crushing of tubes compressive strength results. However re-shuttering and re-propping can be done if the required strength is attained as per the instructions of Structural Consultant / Architect/ Client.

4.11. CLEANING AND OILING OF FORMS

The contractor shall ensure that the surface of the forms that will touch the concrete shall be free from encrustations of mortar, grout, or other foreign material. Temporary openings shall be left at the bottom of formwork to enable sawdust, shavings, wire off-cuts and other foreign material to be removed from the interior of the forms before the concrete is placed. Compressed air shall be used to clean the complete formwork and remove all traces of duct and debris before pouring concrete the temporary holes shall then be closed.

The surface of the forms to be in contact with the concrete shall be coated with a reliable coating that will effectively prevent the adherence of concrete and will not stain the concrete surfaces. After each use, the surfaces of forms which have been in contact with concrete shall be cleaned of mortar and any other material sticking to them, then well wetted and treated with form oil approved by the Architect/ Client.

The Contractor shall provide commercial form release agent that will not bond with, stain or adversely affect concrete surfaces and will not impair subsequent treatment of concrete surfaces.

4.12. OPENINGS / INSERTS

Contractor shall provide all required openings, pockets, inserts as detailed in drawings. The Contractor shall provide required material and labour for fixing and supporting during concreting. In its quoted price, it is imperative to consider that all openings and pockets shall be de-shuttered with care and all corners of openings shall be preserved, ie shall be in correct line and level. After concreting the openings shall be secured against any accident by proper covering and guard rail, warning notice, lighting, etc for which no extra cost is payable to the Contractor.

5. REINFORCED STEEL WORK

5.1 SCOPE OF WORK

The work to be done under this section consists of furnishing, cutting, fabricating, bending, placing and tying steel reinforcement in concrete structures or else where as shown on the drawings or directed by the PMC/ Engineer-in-charge . The scope of this section of this section of specifications as laid down herein.

5.2 APPLICABLE STANDARDS

IS-432	Specification for Mild steel and medium tensile bars and hard drawn steel wire.
IS-1139	Specification for hot rolled mild steel, medium tensile steel and high yield strength steel deformed bars for concrete reinforcement.
IS-1566	Specification for plain hard drawn steel wire fabric for concrete reinforcement
IS-1785	Specification for plain hard drawn steel wire for prestressed concrete.
IS-1786	Specification for cold twisted steel high strength deformed bars for concrete reinforcement.
IS-2080	Specification for high tensile steel bars used in prestressed concrete
IS-2751	Code of practice for welding of mild steel structures are folded plates
IS-2502	Code of practice for bending and fixing of bars for concrete reinforcement

5.3 STEEL GRADES

Reinforcements for concrete may be from any of the "grades" of steel indicated below, conforming to the relevant Indian Standards and their latest amendments mentioned against each:

Grade	Description	Conforming to
Fe 250	Mild Steel	IS 432 (Part I)
Fe 490	Hard drawn steel wire	IS 432 (Part II)
Fe 415	High strength deformed/ ribbed steel	IS 1786
Fe 500	High strength deformed / ribbed steel	IS 1786
Fe 550	High strength deformed / ribbed steel	IS 1786

Reinforcing steel may be any of the following types:

Type I Plain round bars (PR)
Type II Welded wire Fabrics (WWF)
Type III Cold Twisted Deformed Bars/ Corrosion resistant bars. (CTD-R)
Type IV Thermo-Mechanically Treated Ribbed bars (TMT)
Type V Thermo-Mechanically Treated Ribbed Corrosion Resistant bars (Copper) Bearing (TMT-CR)

5.4 BIS CERTIFICATION

Material received at the Site shall have BIS Certification mark. Such bundle or coil containing the bars shall be suitably marked with BIS Certification mark. Bars shall also be marked to identify categories. This shall be done as per IS: 1387.

In case bars are without BIS Certification mark, the manufacturer shall give a certificate stating the process of manufacture, chemical composition and mechanical properties. Each certificate shall indicate the number or identification mark of the cart to which it applies, corresponding to the number or identification mark to be found on the material.

All reinforcements shall be free from loose mill scale, excessive rust, loose rust, pitting, oil, grease, paint, mud or any other foreign deleterious material present on the surface. Cleaning should be done to the satisfaction of the Architect/ Client.
Each batch of steel brought to the Site shall be tested prior to use. Cost of all tests shall be borne by the Contractor.

Material acceptable as per IS Specifications will be allowed into the Project. All rejected material shall be removed from the Site by the Contractor within 30 days of its rejection. If the same is not done, the Architect/ Client can get work done by third party at the contractor's risk and cost shall impose a penalty of Rs 500 (Rupees Five Hundred only) per metric ton per day. This will be without any appeal and shall not be subjected to arbitration.

5.5 STORAGE

Reinforcement bars received at the Site shall be stored on hard, concreted platform and clear of the ground to a minimum of 300 mm with the use of timber sleepers or any other means. Reinforcements shall be kept covered by tarpaulins or plastic to avoid excessive corrosion or any other contamination. It is advised to follow storage methods as described in IS: 4082. The Contractor shall comply with the instruction of the Architect/ Client on method of stacking of steel.

Reinforcement steel shall be stored in such a manner as to avoid distortion and to prevent deterioration and corrosion. Prior to assembly of reinforcement on no account any oily substance shall be used for removing the rust.

5.6 QUALITY ASSURANCE

1. Supervisory staff shall have qualification and experience in the above field.

2. Welders qualified and having approved certificates for welding shall be employed.

5.7 HANDLING

1. Bend test requirements shall conform to the following and shall be based on 1800 bends of full size bars around pins.

Bar diameter (mm)	Pin diameter for test bend
10, 12,16	3.5 x bar dia
20, 22, 25	5.0 x bar dia
28, 30, 32	7.0 x bar dia

2. Spacers shall be of any of the following – Wire, Precast concrete, Moulded plastic

3. Spacer material shall be of durable quality and shall not lead to corrosion of reinforcement or spilling of concrete. Precast concrete spacers shall be of the same mix as that of surrounding concrete.

4. Tying wire shall be of 18 G black annealed mild steel wire or other approved type double fold to tie the reinforcements.

5. Cover blocks shall be non-corrosive material such as plastic, but not wooden or broken bricks or stone. Specially made concrete blocks shall be used. Such cover blocks shall be cast from concrete and not from cement mortar; strength of these blocks shall be equal to the concrete in use.

6. Tying wire shall be of 18G black annealed mild steel wire or other approved type double fold to tie the reinforcements. It shall be face from rust, oil, paint, grease, loose mill seals or any other deleterious material undesirable for concrete or reinforcement or which may prevent adhesion of concrete to reinforcement.

5.8 UNIT WEIGHTS

Unit weights payable per meter shall be as follows:

6 mm □	0.22 kg/ rm
8 mm □	0.39 kg/ rm
10 mm □	0.62 kg/ rm
12 mm □	0.89 kg/ rm
14 mm □	1.21 kg/ rm
16 mm □	1.58 kg/ rm
18 mm □	2.00 kg/ rm
20 mm □	2.47 kg/ rm
22 mm □	2.98 kg/ rm
25 mm □	3.85 kg/ rm
28 mm □	4.83 kg/ rm
32 mm □	6.31 kg/ rm
36 mm □	7.99 kg/ rm
40 mm □	9.86 kg/ rm

5.9 DETAILED METHODOLOGY

A. CUTTING AND BENDING

1. Flame cut and hot bending is absolutely forbidden.
2. Cut and bend reinforcement to approved shop drawings and details shall be used.
3. Bars to be cold-bend, either mechanically or by hand, but to correct radius using proper tools, machine and platform and confirming to IS 2502-1963.
4. Do not rebend without approval. In case of re bending, care shall be taken that the rating of bend is not less than 4 x bar dia at construction joints for plain steel bars and 6 x bar dia for high strength bars.
5. Reinforcement projecting from concrete shall not be bent without approval.
6. Bar bending schedule to be submitted for approval of the Structural Consultant to the Architect/ Client prior to commencement of any cutting, bending and binding of steel at site.
7. Cracked end of bars shall not be used on this Project.

8. Bars should be inspected for visible defects such as cracks, brittleness, excessive rust, loose mills scale, etc.

B. WELDING

Do not weld reinforcement unless authorized by the Consultants/ Architect/ Client and recommended by the manufacturers.

1. Site welding shall be done with suitable safeguards and techniques.
2. Welding, if approved, may be used for:
3. Lapping reinforcement in position
4. Fixing reinforcement to other steel members.
5. The length of run deposited in a single pass shall not exceed 5 x bar diameters. If a longer welded length is required divide into sections with the space between runs not less than 5 x bar diameters.
6. Welded joints:
   a) Shall not be made at bends in reinforcement.
   b) Tagger joints in parallel bars of principal reinforcement unless otherwise approved.
7. The distance between staggered joints shall not be less than the end anchorage length joints.

C. MECHANICAL SPLICING

1. To comply with ISI 456-2000. ACI 318-1983 and ACI 439-3R-83.
2. Use as indicated in structural drawings.
3. Consultant has to approve mechanical splices before using it at site.

D. INSPECTION

1. Ensure that the reinforcement placing is checked by Architect/ Client.
2. Ensure that the Formwork to receive the reinforcement is clean and free from debris.
3. Cracked end of bars to be cut out.

E. ANCHORING

Anchoring of bars and stirrups shall be provided exactly as detailed in the structural drawings or as directed by Architect/ Client/ Structural Consultant.

In case of reinforcement steel in tension, deformed bars may be used without end anchorage provided the development length requirement is satisfied. Hocks shall normally be provided for plain bars in tension. Development length of the bars shall be determined as per relevant clauses of IS: 456 - 2000.

The anchorage length of straight bar in compression shall be equal to the Development length of the bars in compression as specified in relevant clause of IS: 456 - 2000.

F. LAPPING OF BARS

Laps shall be strictly as per the structural drawing or as directed by the Architect/ Client/Structural Consultant. For general guidance the following principles shall be followed as given in IS: 456 – 2000

1. As far as possible bars of the maximum length available shall be used.

2. Laps shown on drawings or otherwise specified by the Structural Consultant will be based on the Contractor using bars of maximum length.

3. In case Contractor wishes to use bars of shorter length, laps shall be provided at the Contractor's expense in the manner and the locations approved by the Structural Consultant.

4. Splices shall be provided as far as possible away from the sections of maximum stress and be staggered.

5. Not more than half of the bars shall be spliced at a section

6. If more than half of the bars shall be spliced at a section, special case shall be ensured such as increasing length of lap or closer spacing of stirrups around the length of splice.

7. Lap splice shall not be used for bars having diameter larger than 36 mm. For larger diameters bars it may be welded. Lap length including anchorage value of hooks in flexural tension shall be La (as defined in Article 25.2.1 of IS: 456-2000) or 30 times the diameter of the bar whichever is greater and for direct tension 2La or 30 times the diameter of the bar whichever is greater. The straight length of lap shall not be greater than 15D or 20 cm, whereas D is the diameter of the bar.

8. Lap length in compression shall be equal to the development length in compression calculated as described in relevant clause of IS: 456-2000 or as specified in the structural drawing but not less than 24 times the diameter of the bar.

9. Overlapping bars shall not touch each other and these shall be kept apart with concrete between them by 25mm or 1.25 times the maximum size of the coarse aggregate, whichever is greater.

10. When above is not possible, the overlapping bars shall be bound together at intervals not exceeding twice the diameter of such bars with two strands of annealed binding wise of 0.90mm to 1.6mm diameter twisted together tightly.

11. As and when necessary welded laps shall be proved as specified by the Structural Consultant.

G. SECURING REINFORCEMENT

1. Adequately secure with tying wire or approved steel clips.

2. Bend the tying wires well back clear of forms.

H. CONCRETE COVER

1. Shall be in accordance with ISI: 456-2000 and as per the instructions in structural drawings.
2. Footings, retaining walls and Similar members in contact with earth
   but not cast against earth -50 mm
3. Slabs - 20 mm
4. Walls, ribs - 20 mm
5. Beams:
   For main bars - Min.25 mm or dia. of the bar
   For stirrups - 15 mm
6. Columns - 40 mm
   Columns less than 20 cms - 25 mm
7. Water tanks:
   In contact with water - 40 mm

In contact with air - 20 mm
8. Walls in contact with water / Earth - 40 mm

I. SPACERS CHAIRS AND OTHER SUPPORTS

1. Provide necessary supports to maintain reinforcement in its correct position.

2. Provide spacer bars of same diameter as longitudinal bars but not less than 25mm diameter between two layers at 1.5 mm centers except where bundled bars are detailed.

5.10 PRECAUTIONARY MEASURES

1. Do not insert bars into placed concrete.

2. Do not damage forms and form linings, if any when fixing reinforcement.

5.11 ADJUSTMENT AND CLEANING

1. Check reinforcement prior to and during placing concrete with particular attention to the top reinforcement in Cantilever sections. Ensure that reinforcement is clean and free from corrosive pitting, loose rust, loose mill scale, oil and other substances, which may adversely affect reinforcement concrete or the bond between the two.

2. Protect the projecting reinforcement from weather where the rust staining of exposed concrete surfaces may occur.

5.12 MODES OF MEASUREMENTS

1. Reinforcement shall be measured as follows (Contractor shall account for all these in his quoted rates):

2. Length of different diameters of bars actually used including laps shall be measured nearest to a centimeter and their weights calculated as shown on the drawings or as instructed by the Structural Consultant.

3. Weights per metre shall be as per IS code.

4. Rolling margin to be considered in quoted rates.

5. Rate build-up shall include, in addition to cost of material (ie will not be measured and paid for separately):

Cover blocks (PVC or concrete) of required thickness for keeping reinforcement bars in position. Unauthorised overlaps (allowed for Contractor's convenience), spacer bars, chairs and ties.
Cutting, bending, placing and fixing in position in any size and shape and placing in position as per detailed drawings Binding wire as approved (will not be measured and hence not paid separately)
Wastage Cleaning of bare reinforcement Welding where required as shown in drawings and specifications

5.13 APPROVED MAKES

Reinforcement bars shall be procured from one of the following manufacturers only. (Reinforcement bars from other sources will not be approved)

Name of Makes

a) SAIL
b) TISCO

6. STRUCTURAL STEEL WORK

6.1. GENERAL DESCRIPTION

The contractor shall furnish all materials, labor operation, equipment, tools and plant and incidentals necessary and required for the completion of all metal work in connection items of metal work as called for in the drawings. The drawing and specifications cover the major requirements only. The supplying of additional fastenings, accessory features and other items not mentioned specifically herein but which are necessary to make a complete installation shall be a part of the contract.

6.2. APPLICABLE STANDARDS

IS-226-1975 - Structural Steel (standard quality)(fifth revision)

IS-456-1978 - Code of practice for plain and reinforced Concrete (third revision)

IS-696-1972 - Code of practice for general engineering drawings (second revision)

IS-786-1967 - (supplement) SI supplement to Indian standard conversion factors and conversion tables (first revision)

IS-812-1957 - Glossary of terms relating to welding and cutting of Metals

IS-813-1961 - Scheme of symbols for welding

IS-814 - Covered electrodes for metal arc welding of structural steels:

814 (part -1)-1974 part-1 for welding products other than sheets (fourth revision)

IS-816-1969 - Code of practice for use of metal arc welding for general construction in mild steel (first revision)

IS-817-1966 - Code of practice for training and testing of metal arc welders (revision)

IS-819-1957 - Code of practice for resistance spot welding for light assemblies in mild steel

IS-875-1964 - Code of practice for structural safety of buildings: Loading standards (revision)

IS-919-1963 - Recommendations for limits and fits for engineering (revision)

IS-961-1975 - Structural steel (high tensile) (second revision)

IS-962-1967 - Code of practice for architectural and building drawings (first revision)

IS-1024-1979 - Code of practice for use of welding in bridges and structures subject to dynamic loading (first revision)

IS-1030-1982 - Carbon steel castings for general engineering purposes (second revision)

IS-1148-1973 - Hot-rolled steel rivet bars (up to 40 mm diameter) for structural purposes (second revision)

IS-1149-1982 - High tensile steel rivet bars for structural purposes

IS-1261-1959 - Code of practice for seam welding in mild steel

IS-1278-1972 - Filler rods and wires for gas welding (second revision)

IS-1323-1962 -Code of practice for oxy-acetylene welding for structural work in mild steel (revision)

IS-1363-1967 - Black hexagon bolts, nuts and lock nuts (diameter 6 to 39 mm) and black hexagon screws (diameter 6 to 24 mm) (first revision)

IS-1364-1967 - Precision and semi- precision hexagon bolts, screws, nuts and lock nuts (diameter range 6 to 39 mm) (first revision)

IS-1367-1967 - Technical supply conditions for threaded fasteners (first revision)

IS-1393-1961 - Code of practice for training and testing of oxy-acetylene welders

IS-1395-1982 - Molybdenum and chromium molybdenum vanadium low alloy steel electrodes for metal arc welding (second revision)

IS-1477 - Code of practice for painting for painting of ferrous metals in buildings: 1477 (part-1) 1971 part-1 pretreatment (first revision) (part-2) 1971 part-2 painting
IS-1929-1961 - Rivets for general purposes (12 to 48 mm diameter)
IS-1977-1975 - Structural steel (ordinary quality) (second revision)
IS-2062-1984 - Weld able structural steels (third revision)
IS-2155-1962 - Rivets for general purposes (below 12 mm diameter)
IS-3613-1974 - Acceptance tests for wire-flux combination for submerged-arc welding of structural steels (first revision)
IS-3757-1972 - High-tensile friction grip bolts (first revision)
IS-4000-1967 - Code of practice for assembly of structural joints using high tensile friction grip fasteners
IS-5369-1975 - General requirements for plain washers and lock washers (first revision)
IS-5370-1969 - Plain washers with outside diameter 3Xinside diameter
IS-6419-1971 - Welding rods and bare electrodes for gas shielded arc welding of structural steel
IS-6623-1972 - High tensile friction grip nuts
IS-6649-1972 - High tensile friction grip washers
IS-7205-1974 - Safety code for erection of structural steel work
IS-7215-1974 - Tolerances for fabrication of steel structures
IS-7280-1974 - Bare wire electrodes for submerged arc welding of structural steels
IS-8500-1977 - Weld able structural steel (medium and high strength qualities)

6.3. SHOP DRAWINGS

1. Shop drawings for trusses, bracings, purlins, columns, ties, base plates, crane girders, etc.
2. Indicate profiles, sizes, spacing and location of structural members, connections, attachments, fasteners, cambers, loads and designs of joints.
3. Indicate welded connections using standard welding symbols and net weld lengths.
4. Indicate the method of erection, shop and field joints.
5. Indicate and identify all transportable parts and sub assemblies, associates with special erection instructions, if any.
6. Provide design calculations for splices, joints, other details not specifically detailed in design drawings on fabrication drawings considering standard detailing practices and developing full member strengths.
7. Submit 3 sets of shop drawings to PMC/ Engineer-in-charge for approval.
8. Allow three weeks for PMC/ Engineer-in-charge to approve shop Drawings.

6.4. PRODUCTS

1. MATERIALS

1. Structural steel members.
2. Structural tubing.
3. Welding materials.
4. Primer.
5. Shear studs.

All metal materials shall be free from defects impairing strength, durability and appearance and they shall have structural properties that comply fully with the standards set out in clause 3/2.61.1.3, which follows. All ferrous metal shall be free from rust, scale and other defects. All non- ferrous metal shall have uniform finished surfaces, machined and buffed, free from defects. All sections shall conform accurately to sizes and shapes required.

2. FABRICATION

1. Fabricate structural steel members in accordance with IS Specifications 800 section V and approved shop drawings.
2. Defective material used shall be replaced by the contractor.
3. Fabricated items delivered at site shall be suitably protected from any damages.

3. FINISH

Clean, prepare and shop rime structural steel members. Do not prime surfaces to be field welded or in contact with concrete.

6.5. EXECUTION

1. Erect structural steel in accordance with IS Specifications.
2. Make provision for erection loads and for sufficient temporary bracing to maintain the structure in proper plumb and in true alignment until completion of erection and installation of permanent bracing.
3. Do not field cut or alter structural members without approval of PMC/ Engineer-in-charge .
4. After erection, prime welds, abrasions and surfaces not shop primed, except surfaces to be in contact with concrete.
5. Members shall be cut mechanically by saw or shear or by oxy acetylene flame and not by electric metal arc. Cut edges shall be ground as per IS 823.Cutting tolerances shall be: Members connected at bolt ends: ±1 mm. 0R Other members: ± 3 mm.
6. All bolt holes shall be drilled and to the sizes specified in drawings.
7. Tolerance for spacing between two holes: ±1 mm.
8. Tolerance between two perpendiculars of any oval holes: ± 1 mm.
9. Bolt holes for field joints shall be drilled in the shop to the required diameter and tested.
10. Drilling holes for standard sizes of varies can be reamed to next higher sizes. The tolerance for hole reaming shall not exceed 15% of the total number of holes for one joint.

6.6. PREPARATION OF MEMBERS OF WELDING

1. Proper jigs and fixtures shall be used to ensure correct positioning of structural members during assembly.
2. Sharp edges, rusting of cutting edges, notches, irregularities, and fissures due to faulty cutting shall be chipped and ground.
3. Edge preparation for welding shall be done properly taking care of cleaning. Providing dry surface, removing grease, dust of dirt, foreign matter, etc.
4. Finished dimensions of structure shall be ensured after taking into account the shrinkage and distortions during welding.

6.7. WELDING

1. PERSONNEL

Welders shall be fully trained, experienced and certified by the recognized welding institutes.
Welders' qualification tests shall be as per IS 823 and approved by PMC/ Engineer-in-charge .

2. EXECUTION

a) Welding shall be done in accordance with IS 823.

b) Welding parts shall be marked with welders' identification.

c) Protect the welded parts, electrode wires against wind and rain.

d) Discontinued seams shall be melted before resuming welding operation.

e) Welding seams shall be cooled slowly and not by any other quick methods.

f) Before welding a second layer over the existing layer of weld, the layer shall be cleaned metal bright by light chipping and wire brushing.

g) Execution shall proceed in strict compliance with section 2/7 safety procedures.

3. APPROVAL

a) Welded parts shall not have any deformations.

b) Welded joints should compensate for contraction due to welding.

c) Defective welds must be rectified.

d) Weld seams shall correspond to design shapes and dimensions.

e) Weld seams shall not have cracks, fusion, under cuts, rough surfaces, burns, blowholes, and incomplete penetration.

f) Approval of finished elements, inspections and tests shall be as per annexure

6.8. BOLTING

1. MATERIAL

a) Bolts, nuts shall be in accordance with IS 1367 and tested as per IS 1608.

b) Washers shall be as per IS 2016.

2. PREPARATION

a) Members shall be assembled for bolting with proper jigs and fixtures to sustain the assemblies without deformation and bending.

b) All sharp edges, shavings, rust, dirt, etc. shall be removed before assembly.

c) Before assembly the contacting surfaces of the members shall be cleaned and given a coat of primer.

d) Temporarily the assembly shall be done.

e) And checked for co-axiality of the holes after which the assembly shall be finally bolted.

3. EXECUTION

a) Bolts shall be fixed after all the defects have been rectified and approved by PMC/ Engineer-in-charge .

b) Bolts shall be tightened form the center of joint towards the edge.

4. IDENTIFICATION

a) Structural members prior to dispatch for erection shall be marked with a weather proof light colored paint. The size and thickness of members shall be so chosen as to facilitate easy identification.

b) Structural members small in size shall be bundled or crated and shall be marked with metal tags for bundles and painted on crates for identification with particulars of the bundle/ crate size, weight, etc.

6.9. SHOP – APPROVALS

1. PRE ASSEMBLY

a) Pre assembly of bolted structures shall be done for all elements as well as for the entire structure in conformity with the 'holes for field joints'

b) Steel structures having same type of welding the shop test pre assembly shall be performed at least one member out of ten members.

2. INSPECTION

a) Contractor to provide facilities for PMC/ Engineer-in-charge to inspect the steel assembly, welding, bolting, painting etc. at any time during fabrication of members.

b) PMC/ ENGINEER-IN-CHARGE / ENGINEER-IN-CHARGE shall have the access to the fabrication shop at all times for satisfying himself regarding the fabrication of steel items to the drawings and specifications.

c) Shop approval by the consultants/ PMC/ Engineer-in-charge is only mandatory.

d) Contractor to bear all the expenses for testing required by consultants/ PMC/ Engineer-in-charge for satisfying regarding the quality of workmanship.

e) Contractor to furnish necessary tools, gauges, instruments, technical and non-technical personnel for shop tests at his own cost.

3. APPROVALS:-

A. INTERMEDIATE APPROVALS

For part of the work that cannot be inspected later.
For part of the work that will be difficult to perform inspection and even if done results ate not satisfactory

a) PARTIAL APPROVALS

i) To the structural steel members and assemblies before the primer coat is applied.
ii) Of materials used for fabrication.
iii) Of test erection.

iv) Of markings.
v) Of fillet joints.
vi) Of plain surfaces.
vii) Of special features such as rollers, etc.

b) FINAL APPROVAL

i) To all elements and assemblies of steel structures after having a shop primer coat and ready for delivery.
ii) Includes partial approval
iii) Of shop primer coat.
iv) Of mode of loading and transport.
v) Of storage of materials.

c) APPROVED FABRICATORS

All metal work fabricated shall be approved by the structural consultant/ PMC/ Engineer-in-charge . The entire work shall be carried out by workmen skilled in this kind of work in a shop fully equipped to carry out all phases of fabrication in accordance with the best-accepted trade practices.

6.10. PAINTING

1. PREPARATION

a) Surface to receive primer coat shall be sand blasted/ wire brushed, free of dust, oil, rust. Etc.
b) Surfaces not accessible to painting shall be filled with approved type of oil and putty.
c) Surface shall be completely dry.
d) Surfaces where water or aggressive agents may collect during transportation, storage, erection and operation shall be filled with putty and provided with drainage holes
e) Structural steel members are inspected and approved.
f) Welds are approved.
g) After satisfying the above criteria the surfaces ate to be provided with one coat of red oxide/ zinc chromate primer to the satisfaction of PMC / Engineer-in-charge before the material is dispatched for erection.

2. DO NOT PRIME THE FOLLOWING AREAS

a) Surfaces to receive weld at site.
b) Surfaces bearing markings.
c) Surfaces as indicated in drawings.
d) Planned surfaces shall receive a coat of hot oil or any approved resistant lubricant only.
e) To coat the surfaces with hot oil to holes for links.
f) To give a coat of cement wash for any members either embedded or in contact with concrete.
g) To give a bituminous coat for members in contact with ground, gravel, brickwork and moistures.
h) Contractor to give a further coat of red oxide paint after erection and placing in position of the assembly if called for by the PMC/ Engineer-in-charge .

3. PACKING, TRANSPORTATION, DELIVERY:

a) Structural steel members shall be marked and approved in shop before packing and loading for transportation.
b) Adequate packing must be done for all the steel members to protect them against warping during loading and unloading.
c) Suitable lifting devises to be used for loading and unloading.
d) Additional steel bracing to be providing for all slender projecting members to prevent any warping during transportation loading and unloading.
e) Loading and transportation shall be done as per the transportation rules.
f) To provide additional splice joints where required in consultation with consultants/ PMC/ Engineer-in-charge in case the members to be transported are beyond the limitations of transporting system.
g) To secure all small parts including gusset plates fish plates by securing them with wire to their respective parts.
h) To crate all bolts, nuts and washers.
i) All structural parts to be delivered in the order required for construction and as per instructions of PMC/ Engineer-in-charge and shall accompany the following documents.
   i) Quality and quantity of structure or members.
   ii) Location of members in the structure
   iii) Description of structure
   iv) Identification number'
   v) Building/ job symbol

4. STORAGE AND PREPARATION OF MEMBERS PRIOR TO ERECTION

a) Place for storage of steel member shall be prepared in advance and got approved by the PMC/ Engineer-in-charge .
b) To provide concrete platform at the site for preliminary erection work.
c) To verify the quality of material obtained at site and for workmanship to the specifications and drawings.
d) To verify whether the parts obtained at site is free from defects due to loading, unloading transportation.
e) To avoid warping of members during unloading by taking sufficient precautionary measures.
f) To store the members as per the symbol and markings and in order of erection.
g) To place the steel members at least 150mm above the platform on wooden or steel locks for protection against direct contact with ground and to permit drainage of water.
h) To equip for rectification of members like straightening at site and to provide sufficient space for the same.
i) To see that the parts are clean before erection.

5. FIELD ERECTION

a) To get approvals of foundation, column pedestals or other related structure on which the structural steel members are to be erected.
b) To get approvals of the members receiving structural steel members regarding their levels dimensions, alignments and verticality well in advance.
c) To carry out any minor discrepancies at no additional cost.
d) To get approvals of pockets, bolt locations, levels of base plates before erection.
e) Erection to commence after satisfying the above conditions.
f) Erection to be done in an organized way so that any individual member is not subjected to instability during the erection time.
g) Precautionary measures to be taken during erection of trusses, purlins and other steel members by providing proper bracing

h) Faulty erections done without caring for safety of members and of personal shall be made good at no additional cost.
i) Contractor is not relieved of his responsibilities, guarantees even after the PMC/ Engineer-in-charge approves the fabrication, erection, etc. at any stage of work.
j) Contractor is solely responsible for the correctness accuracy and quality of the fabrication erection and final approvals to be obtained by the PMC/ Engineer-in-charge .

6. ERECTION AND TOLERANCE

a) To check and inspect before, during and after erection.
b) Damage during transportation.
c) Alignment of structure.
d) Erection sequence
e) Progress
f) Workmanship, anchor bolts which shall To erect members as per the predetermined plan approved by the PMC/ Engineer-in-charge .
g) To position and level the structure including aligning and to plumb the stanchion and fixing every member in position with bolts, erection bolts, weld as per design and drawings.
h) To inform the PMC/ Engineer-in-charge of any variation, deviation in location of foundations deviate the prefabricated members.
i) Structural consultants/ PMC/ Engineer-in-charge to give suitable solutions in case of above deviations well in advance for the contractor to proceed with the fabrication of members including any modifications necessary.
j) Contractor to rectify an minor deviation in foundations, location of steel bolts and orientation of bolthole positions at no extra cost.
k) To erect structural steel members ensuring that the system is stable against inherent weight, wind and any erection trusses.
l) To anchor and fasten the erection joints after duly checking the plan, elevation positions of the members with reference to the drawings after the approval of PMC/ Engineer-in-charge.
m) To fasten bolts to the final position with bolt heads and nuts resting on the member and on tapered with members having a sloping surface.

7. FINAL ACCEPTANCE AND HANDING OVER THE STRUCTURE

a) Contractor to submit As-built shop drawings for the approval of the structural consultant/PMC/ Engineer-in-charge , as per the stipulation given in conditions of contract.
b) Documents to be submitted for final acceptance are as follows:

i. Shop acceptance drawings.
ii. Quality certificate for structural members, plates, flats, bolts.
iii. Quality certificate for material used for fabrication including electrodes, welding wire, bolts, nuts, washers etc.
iv. List of welders who welded the structures and their certificates for having undergone a welding course.
v. Acceptance and intermediate control procedure adopted during the process of fabrication assembly, transportation, delivery and erection or structure.

6.11. MODES OF MEASUREMENTS

1. Payment of structural steel members including bolts, nuts, washers, gusset plates, etc, will be done on weight basis.

2. The weight of members will be assessed from the final fabricated and approved drawings and the respective bill of materials prepared by the contractor and approved the structural consultant/ PMC/ Engineer-in-charge

3. The weight of members shall be as per IS handbook.

4. Sections different than mentioned in IS handbook shall be taken as per manufacturers information.

5. No rolling tolerance will be allowed

.

6. Built up of members will be paid as per the actual weight of the members.

7. Gusset plates shall be paid to the nearest rectangle enclosing the shape and no deduction shall be made for any skew cuts.

8. Welds, bolts, anchors, washers, etc. will not be measured and paid for separately.

9. Payment does not include any other related temporary works connected with this work including welds, shims, wedge plates, etc.

10. Rates to include any trimming, straightening, edge preparation, preparation and approval of shop drawings, and one coat of red oxide/zinc chromate primer and also including any handling, rehandling, loading and unloading, transportation to the site of work and returning surplus material to the PMC/ Engineer-in-charge at the place requested by him

.

11. Rate to include necessary scaffolding, temporary support, tool and tackles, touching up primer coat grouting etc.

A. GROUTING

1. To level, align and plumb the structural steel work and the base of stanchions by providing steel shim plates.
2. To align anchor bolts in foundation to the required level, location and orientation by using templates.
3. To clean the underside of base plates, pockets to receive grout by using compressed air.
4. To use cement mortar 1:2, 1 of cement and 2 of sand, non-shrink grout under base plates.
5. To use grade M30 concrete to fill up the grout pockets left for fixing anchor bolts.
6. To pour the grout under a sufficient head and tam until the voids are thoroughly filled and the grout overflows.

B. TOLERANCES

1. Steel work for line and level ± 3mm
2. For structural steel for plumb 3.5mm for 10M and not more then 7mm for 30M
3. To follow any tolerance criteria provided on the drawings.
4. To provide tolerances for all structural steel members as per IS code other than that what is mentioned in a, b and c.

Annexure- A

Inspection of test	**Coverage**	**Procedure**	**Evaluation findings &remedy of Defect**
Inspection of Weld Seam	All welds	Naked Eye or Lens	All faults welds shall be rectified

Checking of Sizes	At least one for each weld	Ordinary measuring instruments (rule, templates)	Should faulty weld be found, all welds shall be checked and all defects shall be rectified.
Mechanical tests for welding performance and electrode		As per IS: 823	

Annexure- B

Inadmissible weld defected and tolerance allowed for welds

Defects	**Detailing of sketching of defect**	**Allowed tolerances & remedy of defects**	**Cause of defects**	**Mode of finding defects**
Unsatisfactory appearance	Uneven width rugged seam	At discretion cut weld & re-weld	Uneven welding progress, voltage fluctuations, varying arc length, negligence inexperienced welded	External (visual inspection
Unsatisfactory shape	Shallow or jutting welds	No variance from design shape shall be allowed	Negligence	Visual inspection template checking
Incomplete weld		Not allowed fill in weld		Template checking
Molten metal flow		Not allowed fill in weld wrong	Excessive melting, ions handling of electrodes	Visual inspection
Pits	Not allowed cut & re-weld		Wrong welding technique	Visual inspection
Surface cracks		Not allowed cut & re-weld	Grerat stresses, sudden cooling, wrong type of electrodes	Visual inspection
Incorrect sectional dimensions A) Depth weld		B1 = ±2mm B2 = ±2mm B = ±1mm C = ±1mm Chisel & grid	Negligence	Template checking
Insufficient	For weld lengths 11+5mm, for 12+10mm for shorter seams cur & re-weld or complete to length		Negligence	Rule checking

Back cuts	If 0.5mm for 10mm & C1mm for 10mm replace relevant members		Burnt material, excessive melting	Visual inspection
Surface porosities	Max 5% of seam area cut & re-weld		Frequent interruptions or welding electrodes inadequately covered	Visual inspection

7. BRICK MASONRY

7.1. GENERAL.

Brick Masonry shall consist of all work required in connection with constructing brick masonry at locations shown on drawings including, but not limited to, furnishing brick, Portland cement and sand for mortar and all other materials, and mixing, placing brick masonry as per bill of quantities.

7.2. MATERIALS.

1. All Portland cement for mortar shall be furnished by the Contractor and shall conform to the applicable requirements specified in the section- 3.5.1.

2. All sand for mortar shall be furnished by the Contractor and shall conform to the applicable requirements for sand specified in the section- 3.5.2.

3. All water used in the manufacture of bricks and in the preparation of mortar shall be free from objectionable quantities of silt, organic matter, alkali, salts and other impurities, and will be tested and approved by the PMC/ ENGINEER-IN-CHARGE as per the guidelines of IS: 456.

7.2.1 MORTAR.

i) MIX: Mortar for all brick masonry, expect where otherwise directed by the PMC/ ENGINEER-IN-CHARGE , shall consist of one part cement to six parts of damp loose mortar sand by volume for brickwork 230mm and above. For brick piers, half brick walls, honey-combed brickwork and hollow (cavity) walls, the mortar mix shall consist of one part cement and four parts of sand. Quantity of water shall be just sufficient enough to produce proper consistency for the intended use. Where directed and approved by the PMC/ ENGINEER-IN-CHARGE , hydrated lime putty, shall be added to the mortar for increased workability. The putty shall, however, not exceed 25% by volume of the dry cement.

ii) Methods and equipment used for mixing mortar be such as will accurately determine and control the amount of each separate ingredient entering into the mortar and shall be subject to the approval of the PMC/ ENGINEER-IN-CHARGE . Mortar shall be mixed only in sufficient quantities for immediate use and all mortar not used within 30 minutes after addition of the water to the mix shall be wasted. Re-tempering of mortar will not be allowed. The mixers shall be thoroughly cleaned and washed at the end of each day's work.

7.2.2 BRICK.

i) All bricks shall be of first class quality made from good brick earth, free from saline deposits and shall be sand moulded. They shall be thoroughly burnt without being vitrified, shall be

regular, uniform in shape and size with sharp and square edges parallel faces and of deep red or copper colour. First class bricks shall be homogeneous in texture and emit a clear ringing sound when struck, and shall be free from flaws, cracks, chips, stones and nodules of lime. First class brick in an oven dried condition shall not absorb more than 1/5 of its weight of water when immersed for one hour in water at 21 to 27 degrees centigrade and shall show no signs of efflorescence on subsequent drying. The average compressive strength of five representative first class bricks shall be 15 N/mm.sq.and shall no result shall fall below 10 N/mm sq. The bricks in general shall conform to the requirements of IS:1077.

ii) All bricks shall be manufactured by the Trench Kiln method or other standard methods approved by the PMC/ ENGINEER-IN-CHARGE . The earth used in manufacturing bricks shall be carefully selected and shall be free from objectionable quantities of lime, gravel coarse sand, roots, or other organic matter salts shall not exceed 0.3% and calcium carbonate shall not exceed 2.0% .

iii) The moulds used in the manufacture of bricks shall be thoroughly sanded before each use and shall be sufficiently larger than the size of the bricks being manufactured to allow for shrinkage in drying and burning. The size ready for use shall be 9" by 4 3/8" by 2 /4" (229X 112X 70mm) and shall weigh between 3.2 to 4.2 Kilograms. All bricks shall have a "Frog" 1/4" deep on one face.

7.3. PLACING.

1. The methods and equipment used for transporting the bricks and mortar shall be such as will not damage the brick nor delay the use of mixed mortar. Brick shall not be placed during rains sufficiently heavy or prolonged to wash the mortar from the brick. Mortar which becomes diluted by rain shall be removed and replaced before continuing with the work. All bricks to be used in brick masonry shall be moistened with water for three to four hours before they are used. The chosen method of wetting shall ensure that all bricks are thoroughly and uniformly wetted. All bricks shall be free from water adhering to their surface when they are placed in the brick masonry.

2. Bricks shall be laid "Frog" upward with mortar joints and in English bond as shown on the drawings or as directed by the PMC/ ENGINEER-IN-CHARGE . Both bed and vertical joints shall be 6mm in thickness completely filled with cement mortar as specified herein, and each brick shall be bedded by firmly tapping with the handle of the trowel. All horizontal joints shall be parallel and all vertical joints in alternate courses shall be directly over one another. Excess mortar at the outer edges shall be removed and joints drawn straight with the edge of a trowel and a straight edge. All anchors and similar work required to be embedded in the brick masonry shall be installed as the work progresses. At the completion of the work all holes or defective mortar joints shall be cut out and repointed.

3. The exterior faces of the walls shall be finished by striking the joints as the work proceeds. The joints shall be struck by raking the green mortar after the brick work has been laid and finishing the joint with a pointing tool. Horizontal joints shall be struck to form a weathered joints and vertical joints shall be struck with a V notch. Care shall be taken that the striking tools do not develop a cutting edge as the object of striking the joint is to compress the mortar into the joints.

4. REINFORCED BRICKWORK: All half brickwork shall be reinforced with 2 no. 6.mm dia M.S. round bars or equivalent reinforcement at every fourth course. The reinforcement cleaned of rust and loose flakes with a wire brush, shall be embedded thoroughly in cement mortar at every fourth course. It shall be cast in or securely fixed to adjoining columns or walls, in a manner approved by the PMC/ ENGINEER-IN-CHARGE .

7.4. CURING AND REPAIR.

1. All brick masonry shall be water cured and shall be kept wet for least seven days by an approved method which will keep all surfaces continuously wet. Water used for curing shall meet the requirements of these specifications for water used in the manufacture of bricks.

2. If, after the completion of any brick masonry work, the brick is not in alignment or level , or does not conform to the lines and grades shown on the drawings, or shows a defective surface, it shall be removed and replaced by the Contractor at his expense unless the PMC/ ENGINEER-IN-CHARGE grants permission, in writing to patch or replace the defective area.

7.5. SCAFFOLDING.

Contractor shall provide safe scaffolding of adequate strength for use of workmen at all levels and heights at his own expenses. Scaffolding which is unsafe in the opinion of the PMC/ ENGINEER-IN-CHARGE shall not be used until it has been strengthened and made safe for use of workmen. Cost of scaffolding etc., shall be included by the Contractor in the unit rate for masonry items.

Damaged, masonry from scaffolding or from any other objection shall be repaired by the Contractor at his own cost.

7.6. TOLERANCES.

The brick work shall be erected plumb and true to line at level with the maximum variation in any storey height of any length of wall being one meter. The maximum tolerance in the length, height or width of any single masonry unit shall be +/- 3mm.

7.7. MEASUREMENT AND PAYMENT.

1. GENERAL.

Except otherwise specified herein or elsewhere in the contract documents, the measurement and payment will be made for the under mentioned specified works related to the relevant items of the bill of quantities.

a) Cutting & chiseling of masonry wherever required.
b) Cement sand mortar used in laying bricks including wastage.
c) Curing & repairing the masonry work.
d) All joint reinforcing bars, reinforcing anchor bars and dove tail anchors.

2. BRICK MASONRY.

a) Measurement:-
Measurement of acceptable completed works of brick masonry will be made on the basis of cubic metres for 200mm thick brickwork and Square metres for 100mm thick brickwork provided and installed in position as shown on the drawing or as directed by the PMC/ ENGINEER-IN-CHARGE .

b) Payment:-

Payment will be made for acceptable measured quantity of brick masonry on the basis of unit rate per cu.m./ per sq.m. quoted in the bill of quantities and shall constitute full compensation for all the works related to the items.

7.8. CEMENT CONCRETE BLOCK MASONRY.

1. SCOPE OF WORK.

The work covered by this section of the specifications, consist of furnishing all plant, labour, equipment, appliances & materials and in performing all operations in connection with the supply and installation of ordinary cement concrete solid and hollow block masonry including wall ties, anchors, damp-proof courses and expansion joints, complete in strict accordance with this section of the specifications and the applicable drawings and subject to the terms and conditions of the contract

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2. APPLICABLE STANDARDS

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Following Indian Standards which are relevant to these specifications shall be applicable.

a) IS: 712-1984
b) IS: 1077-1986
c) IS: 1200 (Pt.III)-1976
d) IS: 2212-1962
e) IS: 3102-1971
f) IS: 3495-(Pts i-iv)-1976
g) IS: 3812-1981
h) IS: 5454-1978
i) IS: 12894-1990

3. MATERIALS.

a. For Block.

Cement, aggregates and water for concrete blocks shall conform to the requirements as specified in the section for plain and reinforced concrete or as approved by the PMC/ ENGINEER-IN-CHARGE .

b. For Mortar.

i) Sand.

Sand for mortar shall be clean and shall comply with the requirements IS codes and as specified in the section for plain and reinforced concrete.

ii) Cement.

Ordinary Portland cement conforming to IS:269 shall be used in preparation of mortar.

iii) Lime.

If directed as an additive by the PMC/ ENGINEER-IN-CHARGE , lime to be used shall comply with relevant IS codes.

iv) Water.

Water shall be clean and free from any harmful impurity. Where the quality of the water is doubtful, it shall be tested in accordance with IS codes.

c. Additives

Additives where used, shall be proprietary products used in the proportions and manner recommended by the manufacturer. The additives shall in no way adversely affect the mortar strength or contain chemicals which may be harmful to other buildings materials. Adding of gypsum to cement is strictly forbidden.

d. Mortars and Grout.

Materials for mortar, sand binding agent and water, shall be mixed by volume or by weight for at least 3 minutes with the minimum amount of water to produce a correctly mixed workable consistency in a mechanical batch mixer. For small jobs, hand mixing may be permitted. The ingredients shall be mixed with just enough water to produce a correctly mixed workable mortar.

Mortar shall be as strong, but no stronger than the materials it bonds together. Mortar shall be mixed in batches which can be used within its setting period. Once a mix begins to dry off it shall be discarded, no ingredients shall be added to it once the setting process has begun.

4. CONCRETE BLOCK MAKING.

a) The solid and hollow blocks shall be machine moulded. The block making machines shall be of the standard approved by the PMC/ ENGINEER-IN-CHARGE . They shall be operated according to the instructions laid down by the manufacturers.

b) The Contractor shall provide test certificates providing the average minimum crushing strength of the blocks prior to the commencement of the construction. Further test certificates shall be provided as required by the PMC/ ENGINEER-IN-CHARGE to ensure that all batches of blocks have the minimum crushing strength specified. The block strengths are to be determined in accordance with IS specs.

c) The test shall be carried out by a laboratory approved by the PMC/ ENGINEER-IN-CHARGE . Evidence shall be produced that the block manufacturer has an efficient method of quality control. The PMC/ ENGINEER-IN-CHARGE will require to periodically test samples of blocks, and the Contractor shall made any necessary arrangements. The method of sampling for all tests shall be in accordance with IS codes.

d) All properties or specifications of blocks, not explained in these specifications or CPWD specifications shall comply with the requirements of I.S. codes, as directed by the PMC/ ENGINEER-IN-CHARGE .

e) The specifications of Hollow block units shall be in conformity with the Indian Standards, according to the requirements. The constituent materials equipment, aggregates, water, process of manufacture including mixing, dimensions including tolerance, density, width of cavities in hollow blocks, bedding joints, surface plain curing, compressive/transverse strength, drying shrinkage, moisture movement, shall be strictly controlled/determined and tested in accordance with the relevant IS codes.

5. SOLUBLE SALT CONTENT.

a) For exposed block work, the contents by weight percent of soluble sulphate, calcium, magnesium potassium and sodium radicals, shall not exceed respectively 0.30, 0.10, and 0.03 percent when ascertained in accordance with IS codes at the cost of the Contractor.

6. REINFORCING AND ANCHORS.

a) Unless otherwise stated reinforcing and anchors shall conform to undermentioned sizes.

b) Tie bars shall be provided at the rate of 3' (0.9m) c/c horizontal, and 16"(0.4m) vertical, of the size and shape as shown in the drawings in cavity block masonry with insulation.

c) Dovetail anchors and slots (if used as an alternate anchorage) shall be not less than 18 gauge galvanized steel.

7. ERECTION.

a) Blocks shall be laid true to line, level and laid in accurately spaced courses in stretching bond with vertical joints of each course located at centre of units in alternate courses below vertical joints shall be buttered the entire height of blocks. Each course shall be bonded at corners and intersections of walls and shall be properly bonded. Courses of block shall be kept plumb throughout and corners, reveals shall be true and in plumb.

Standard width of mortar joints for both horizontal and vertical joints shall be 9-10mm (3/8") mortar joints in walls shall have full mortar coverage on vertical and horizontal faces between the blocks. Mortar joints on walls including struck joints, shall be thoroughly compacted and pressed tight against the edges of the blocks with proper tools. Blocks terminating against soffits of beam or slab construction shall be wedged tight with mortar between the top of the block and the bottom of slab or beam. Control expansion joints shall be kept free from mortar or other debris.

Unless otherwise shown on the drawings of specified by the PMC/ ENGINEER-IN-CHARGE , the spaces around door frames and other materials or built in items shall be solidly filled with mortar. Spaces around the door and window holdfasts shall be filled in with concrete. Work required to be built in with masonry including door frame anchors, wall plugs dovetail anchors and accessories shall be built in as the erection progresses.

b) The block work shall be carried up in uniform manner and no portion shall be carried more than one 1m above the adjoining one at any time. All masonry shall be kept strictly true and square and the whole properly bonded together and leveled round each floor.

c) 7.8.7.3 Sleeves, chases, holes, sinking and mortices for other trades shall be correctly located and formed to the sizes as required by the relevant trades, chiseling of completed walls or the formation of holes shall only be carried out with the approval of the PMC/ ENGINEER-IN-CHARGE .

d) 7.8.7.4 All bolts, anchors, ties, pep sleeves, finishing metal attachments lintels and the like required to be built into the work shall be correctly inserted and executed as the work proceeds. Walls or partitions abutting concrete columns or walls shall be securely anchored and tied with metal anchors or ties at not more than 18"/450mm vertical centers.

e) Wall ties cost in with concrete shall be bent down after the removal of form work and securely jointed into the mortar beds of walling.

f) Walls of blocks indicated as being non-load bearing shall be constructed on the insitu concrete floor slab unit after the floor formwork is struck and the concrete has obtained sufficient strength to support their weight. Toothing into load bearing walls shall not be permitted.

8. SCAFFOLDING.

Contractor shall provide safe scaffolding of adequate strength for use of workmen at all levels and heights at his own expense. Scaffolding which is unsafe in the opinion of the PMC/ ENGINEER-IN-CHARGE shall not be used until it has been strengthened and made safe for use of workmen. Cost of scaffolding etc., shall be included by the Contractor in the unit rate for masonry items.

Damage to masonry form scaffolding or from any other object shall be repaired by the Contractor at his own cost.

9. JOINTING.

a) Jointing is the forming of joints as work proceeds.

b) Joints shall be as follows:

c) Exterior exposed joints shall be tightly formed to a weather joint with the point of the trowel.

d) Interior exposed joints shall be tightly formed to a concave joint.

e) Joints which are subsequently covered with plaster or other finish materials shall be struck flush.

10. TOLERANCES.

All block work shall be erected plumb and true to line and level with the maximum variation in any storey height or any length of wall being one mm in one meter. The maximum tolerance in the length, height or width of any single masonry unit shall be +,-3mm.

11. DAMP PROOF COURSE.

Damp proof courses shall be laid on an even mortar bed, free from projections which may puncture the material. Where the damp proof course is to be stepped only flexible membranes shall be used.

Damp proof course unless otherwise specified shall consist of cement concrete 50mm thick, mixed with approved quality water proofing compound as per manufacturers specifications and shall be laid at required level as per drawings and instructions of the PMC/ ENGINEER-IN-CHARGE . The D.P.C. shall be tamped, consolidated, leveled and edges and corners made to the requirements of drawings and shall include finishing and curing.

12. SOLID BLOCK WORK AROUND OPENING OF HOLLOW MASONRY.

Around all openings in hollow block masonry, the Contractor shall provide solid block work of same thickness as that of hollow block masonry wall and of width as indicated on the drawings. Solid block shall be laid around openings in a manner that these are bonded integrally with hollow block masonry.

13. EXPANSION JOINT.

Where shown on the drawings, expansions joint shall be provided. The joint shall be filled with silicon sealant and finished true to line and level.

14. CURING AND REPAIRS.

a) All block masonry shall be water cured and shall be kept wet for at least seven days, by an approved method which will keep all surfaces to be cured continuously wet. Water used for curing shall meet the requirements of these specifications for water used in the manufacture of blocks.

b) If, alter the completion of any block masonry work, the block is not in alignment or level , or does not, conform to the lines and grades shown on the drawings or shows a defective surface, it shall be removed and replaced by the Contractor at his expense unless the PMC/ ENGINEER-IN-CHARGE grants permission, in writing, to patch or replace the defective area.

15. MEASUREMENT AND PAYMENT.

a) GENERAL.

Except otherwise specified herein or else where in the contract documents, no measurement and payment will be made for the under mentioned specified works related to the relevant items of the bill of quantities. The cost there of shall be deemed to have been included in the quoted unit rate of the respective items of the bill of quantities.

i) Chiseling of masonry, where required.
ii) Providing and fixing all joint reinforcing bars and dove tail anchors.
iii) Providing and filling Class 'D' concrete in the cavity of hollow block masonry.
iv) Providing and laying damp proof courses.
v) Providing and installing expansion joint in block masonry.

b) HOLLOW BLOCK MASONRY.

i) Measurement.

In case of different thickness of slab in different areas or rooms or for any other reasons, whatsoever , if chiseling of masonry is required, the Contractor shall do so at his own cost. Where for any reason what so ever the height of the wall is short of ceiling height shall be made good with Class 'C' nominal mix concrete. This concrete shall neither be measured nor be paid under item of concrete but will be paid for under the item of wall masonry. Similarly where the lintel heights are such that the Contractor has to chisel the masonry or provide cast-in-place concrete to make up the height of the course, no payment will be made for chiseling, but where such cast-in-place concrete is provided, payment for the same will be made at the unit rate of masonry.

Measurement for acceptably works of Hollow block masonry will be made on the basis of number of SqM provided and installed in position as shown on the drawings or as directed by the PMC/ ENGINEER-IN-CHARGE . Each measurement shall be taken to the nearest 1/2". All openings left in the masonry wall will be deducted.

ii) PAYMENT.

Payment will be made for acceptable measured quantity of Hollow block masonry work on the basis of unit rate per Sq M quoted in the bill of quantities and shall constitute full compensation for all the works related to the item.

8. WATER PROOFING

8.1. GENERAL CONSIDERATIONS

It is the intent of this specification to secure a completely water tight basement guaranteed for at least 10 (Ten) years. The contractor shall provide all materials, labour, plant, equipment, incidentals and everything necessary for securing a fully water proof job as called for above.

All water proofing work shall be carried out by specialists approved by the PMC/ ENGINEER-IN-CHARGE . Installation and materials shall be as per best practices for obtaining water proof work and as recommended by the manufacturer.

Water proofing work shall be commenced only after the surface is prepared, cleaned free of dirt, dust and foreign matters, inspected and approved. Compressed air shall be used for effective cleaning of all

surfaces. The vents and other projections through the roof shall be made absolutely secure before waterproofing operation can commence. The stepwise sequence will be as under:

Stage I:

Once the shuttering has been removed, the outer surface of the walls should be thoroughly scrubbed and cleaned. The honeycombed areas, pinholes, gaps etc are filled with polymer cement sand mix. The surface should be properly saturated prior to the application of waterproofing treatment. A layer of 18mm plaster 1:3 containing integral waterproofing chemical

The first waterproofing barrier is polymer modified cementious coating. Two coats are applied at an interval of minimum 4 hours. Sprinkling water for at least 24-48 hours cures the membrane barrier.

After curing operation is over and the surface has dried up, the second barrier waterproofing

8.2. ROOF WATERPROOFING (BRICK BAT COBA)

Brick bat coba treatment shall be got done from an approved agency. The surface should be prepared and construction joint if any are to be raked and cleaned. Cement slurry mixed with approved chemical compound is to be spread on the surface so as to fill the undulation and other porous areas.
15 mm thick cement mortar mixed with approved chemical in Cm 1:4 (1 cement: 4 coarse sand) is laid over the prepared surface.

A layer of brick bat coba is laid over the mortar to required slope. The joints between the brick bats should be kept 15-25 mm wide. These joints be filled with CM 1:4 mixed with specialized chemical compound. Curing shall be done continuously for two days.

The top surface should be finished smooth with 20 mm thick CM (mixed with specified quantity of approved chemical). Curing of the treatment should be done for two weeks.

The side wall shall be provided with 20 mm thick cement plaster 1:4 mixed with specialized chemical compound up to a height of 30 Cm. A 20 mm thick gola with brick bats shall be provided and finished with CM 1:4 mixed with approved chemicals compound. The gola shall be cured continuously for two weeks. The work shall be got done from a specialized agency duly approved by the Consultants.

8.3. TAPECRETE WATERPROOFING

All the chasings or cuttings in the floors and walls shall be carried out prior to the commencement of the treatment. The depressions in the concrete shall be filled with filler made of 1 cement: 1.5 silica sand: 0.52 tapecrete P151 or equivalent by weight. The prepared surface then shall be plastered (18 to 20mm thick) with cement mortar 1:3 mix, mixed tapecrete P151 or equivalent as per manufacturers' specifications.
The plastering shall be carried out throughout the sunken portion and carried up to all sides of the walls. The specialist then shall carry out `TAPECRETE' waterproofing treatment comprising of 3 coats of tapecrete. After 1st coat of tapecrete P151 polymer modified cementitious (PMC/ ENGINEER-IN-CHARGE) spread fibre glass on the wet slurry layer and impregnate with tapecrete P-151(PMC/ ENGINEER-IN-CHARGE) or equivalent slurry. 2nd coat of tapecrete P-151(PMC/ ENGINEER-IN-CHARGE) or equivalent slurry coating over fiber glass fabric, 3rd coat of tapecrete P-151(PMC/ ENGINEER-IN-CHARGE) or equivalent, brush topping on the tapecrete P-151 or equivalent slurry coating. After three coats apply plaster (18 to 20mm) with cement mortar 1:3 mix, mixed tapecrete P151 or equivalent After the first coat of Tapecrete all corners, junctions, joints of pipes and masonry to be sealed with Epoxy putty. The treatment is laid underneath and behind all pipes. The specification on verticals is taken 150mm above the finished floor level. Treatment for sunken portion shall be measured and paid for the horizontal area only on Sqm basis for the Tapecrete work carried out.

8.4. TOILET WATERPROOFING

All the chasings or cuttings in the floors and walls shall be carried out prior to the commencement of the treatment. The depressions in the concrete shall be filled with filler made of 1 cement: 1.5 silica sand: 0.52 tapecrete P151 or equivalent by weight. The prepared surface shall be plastered (12 to 15 mm thick) with cement mortar 1:3 mix, mixed with waterproofing compound. (CICO or equivalent). Apply 2 coats of flexible cementitious water proofing coating master seal 550 manufactured by M/s Master Builders Technologies (I) Pvt. Ltd. which would be water research counsel (UK) certified for use in potable water and would have no leakage when tested under specifications of DIN 1048 and would have 95% greater improvement against water absorption than concrete when tested under specifications of BS 1881 part V, 1983 ISAT. The surface then shall be protected with plaster (12 to 15 mm thick) with cement mortar 1:3 mix, mixed with waterproofing compound. (CICO or equivalent) Water test to be conducted for 2 days, to check for any possible leakage. A guarantee for waterproofing without any leakage to be given for 10 years.

PROTECTION AND SUNK FILLING TREATMENT

Providing, mixing and laying for protection and sunk filling brick bat coba/ Foam concrete/ Any other filling material up to a depth of 200 mm.

1. EXTERNAL WALLS

TREATMENT TO SHRINKAGE / SEPERATION CRACKS AND DEFECTS IN PLASTER

Erecting scaffolding, opening up the defective areas and cracks in 'V' groove up to 5 to 8 mm width and depth as necessary. Providing and applying a brush coat of cement + polymer in proportion 1:1. Refilling the same with polymer modified mortar in proportion 1:3.5 using screened sand and adding polymer by 20% by weight of cement. Curing the same at least 3 days.

TREATMENT WITH WATERPROOF COATING

The wall waterproofing coating system to be used shall be a heavy-duty, high build, elastomeric wall coating system for external walls and other vertical substrates. It shall have a strong, durable and elastic membrane that bridges small cracks and tolerates some movement of the substrate. It is ideally suitable for less sound substrates such as concrete or plaster that contains hairline cracks or that is subjected to movement within itself. The system shall consist of a suitable primer, a 100 % acrylic elastomeric body coat and a topcoat, and the total dry film thickness shall be approximately 320 microns. The system shall pass the 3.0mm Mandrel, with elongation of more than 300 % and subjected to accelerated weathering test with no visible defects after 2,000 hours in the QUV Weatherometer. Its carbon dioxide diffusion resistance shall be 4.4 x 105 u. It shall have a water vapour transmission rate of 48.3 gm/m2/24 hours.

Cleaning the entire surface with water and wire brushing to remove algae, fungi, moss, etc. Providing and applying the heavy duty, high build, elastomeric waterproofing coating system on clean, dry, oil and dirt free, sound substrate in one coat of primer, two coats of body coat & two coats of top coat in required colour.

2. TERRACE/PODIUMS

TREATMENT TO CONCRETE DEFECTS LIKE CONSTRUCTION JOINTS COLD JOINTS, HONEY COMBS & POROUS CONCRETE.

All construction joints, honey combs, cold joints, after casting shall be treated by hacking open the affected area to sound concrete, fixing nozzles and grouting the same, under pressure with cement slurry mixed with plasticizer, and non shrink additive.

TREATMENT TO TERRACE / PODIUM SLAB

The waterproofing system to be used shall be a single component ready-mixed heavy-bodied polyisoprene waterproofing membrane consisting of three layers, with a nominal thickness of 0.8mm minimum. The reinforcement if used, shall be either 225gsm or 300gsm emulsion bond chopped strand fibre-glass mat. The waterproofing system shall be flexible and passes the 3mm mandrel, and shall be able to bridge hairline and minor cracks. When the waterproofing system is not reinforced, it shall have at least 500% elongation. At all detailings like pipe protrusions, rain-water-down-pipes, edges and corners, application of the system shall be sufficiently dressed up and reinforced with fibre-glass reinforcement. Upon completion of the application of the system, the entire surface shall be checked for uniformity to ensure proper application of the system.

Cleaning the surface for treatment by removing dust, dirt etc by wire brushing & water jetting. Providing and carrying out the waterproofing system polyisoprene based waterproofing system in one coat of primer and two coats of the waterproofing system to slab and walls up to 0.30 mtr from slab in two coats brush applied and reinforcing with chopped strand fiber glass mat at upturns and around detailings**.**
The primer used shall be a water based latex primer with solids content up to 36%, the body coat used shall be a polyisoprene based material with 59% solids and it cannot be thinned with water. The formed membrane shall have 527% elongation when not reinforced, tensile strength of 7.7 N/mm2, have no penetration of water, and DFT of 0.8 mm.

PROTECTION FOR TREATMENT ON PODIUM SLAB

Providing, mixing and laying a protective screed 75 mm thickness in slope reinforced with G.I. wel mesh 10 gauge of 100 x100 mm grit welded mesh.

PROTECTION FOR TREATMENT ON TERRACE SLAB

Providing and laying brick bat coba with an average thickness of 115 mm in required slope finish with IPS.

3. WATER TANKS

TREATMENT TO CONCRETE DEFECTS LIKE CONSTRUCTION JOINTS COLD JOINTS, HONEY COMBS & POROUS CONCRETE.

All construction joints, honey combs, cold joints, after casting shall be treated by hacking open the affected area to sound concrete, fixing nozzles and grouting the same, under pressure with cement slurry mixed with plasticizer, and non shrink additive.

TREATMENT TO FLOOR AND RETAINING WALLS OF TANKS

The water proofing material shall consist of rapid-hardening Portland cement, specially treated and graded grain-size distribution, and special chemical ingredients of an inorganic nature. The cementitious waterproofing membrane shall remain waterproofed even under pressure and tested to 7.0 bar, and at the same time allow the concrete to “breathe” by allowing the passage of water vapour through the structure. In addition, the cementitious waterproofing material shall protect the concrete against ground water, aggressive ground water and certain chemical solutions. Cleaning the entire surface by water jetting, wire brushing, etc. Pre-wetting the surface and applying the slurry in two coats with trowel @ 2.0 kg/M2 per coat.

4. SWIMMING POOLS, WATER BODIES AND PLANTERS

TREATMENT TO CONCRETE DEFECTS LIKE CONSTRUCTION JOINTS COLD JOINTS, HONEY COMBS & POROUS CONCRETE.

All construction joints, honey combs, cold joints, after casting shall be treated by hacking open the

affected area to sound concrete, fixing nozzles and grouting the same, under pressure with cement slurry mixed with plasticizer, and non shrink additive.

TREATMENT TO FLOOR AND WALLS

The waterproofing material to be used shall be a cementitious, two-component, polymer-modified, flexible, heavy duty, waterproofing membrane. It can be applied to both horizontal and vertical surfaces. Cleaning the surface for treatment by removing dust, dirt etc by wire brushing & water jetting. Providing and carrying out the two component polymer based, cementitious water proofing treatment to floor and walls of the swimming pools, water bodies etc., in two coats brush applied and reinforcing with chopped strand fiber glass mat at upturns and around detailing. (Measurement shall be as per actual area treated).

The formed membrane shall have 309% elongation at break, tensile strength of 1.2N/mm^2, and have resistance to water up to 3kgf/cm^2.

PROTECTION FOR TREATMENT

Providing, mixing and laying a protective screed in slope up to a thickness 75 mm to base of water body/swimming pool.

PROTECTION FOR TREATMENT

Providing, mixing and rendering a cement mortar up to 40 mm to vertical surfaces.

8.5. MEASUREMENT

Measurement for acceptable completed waterproofing work shall be made on the basis of number of square meter of waterproofing in position, or as shown on the drawings or as directed by the PMC/ENGINEER-IN-CHARGE .

8.6. PAYMENT

Payment will be made for acceptable measured quantity of waterproofing on the basis of unit rate per Sq.meter quoted in the bill of quantities and shall constitute full compensation for all the works related to the item.

8.7. GUARANTEE

The waterproofing work shall be guaranteed for 10 years on the non-judicial stamp paper of Rs.50/-.

9. FINISHING

9.1 GENERAL CONSIDERATIONS

1. All plaster work shall be of the best workmanship and in strict accordance with the dimensions of the drawings. All plastering shall be finished to true levels including plumbs, without imperfections, and square with adjoining work. It shall form proper foundations for finishing materials such as paint etc. Masonry and concrete surface to which plaster is to be applied shall be clean, free from efflorescence, sufficiently rough and keyed to ensure proper bond.

2. Wherever directed all joints between RCC frames and masonry walls, shall be expressed by a groove in the plaster. This groove will exactly coincide with the joint beneath. At the corners of

all windows and doors or other openings and wherever instructed, 24 gauge expanded galvanized metal mesh strips 200 mm wide 450 mm long shall be placed diagonally to prevent plaster cracks.

3. Where grooves are not called for, the joint between concrete and masonry in filling shall be covered by 24 gauge expanded galvanized metal strips, 200 mm wide installed before plastering. The contractor shall supply all necessary labour, material, tools and scaffolding necessary for the completion of the work detailed. He shall be responsible to take proper precautions to all works from damage. Any work rejected through non-compliance with the specifications or damaged work shall be removed and replaced at the expense of the contractor.

4. All chasing, installation of conduits, boxes, etc. shall be completed before any plastering is commenced on a surface. Chasing or cutting of plaster will not be permitted. Broken corners shall be cut back less than 150 mm on both sides and patched with plaster of Paris as directed. All corners shall be rounded to a radius. Contractor shall get samples of each type of plaster work approved by the Architect/PMC/ENGINEER-IN-CHARGE .

5. The materials used for plastering shall be proportioned by volume by means of gauge boxes. Alternatively it may be required to proportion the materials by weight.

9.2 PLASTER WORK

1. The joints in the brick work, concrete blocks, shall be raked to a depth of 15 mm while the masonry is green. Concrete surfaces to receive plaster shall be suitably roughened. All walls shall be washed with water and kept damp for 10 hours before plastering.

2. The plaster unless specified otherwise shall be average of 15 mm thick on walls and minimum 6 mm thick for the ceiling. The finished texture shall be as approved by the Architect/PMC/ENGINEER-IN-CHARGE . The mix for plaster unless otherwise specified, shall be one part cement and four parts sand, to walls and one part cement, 3 parts sand to ceiling.
3. The interior plaster shall be applied in one coat only. The surface shall be trowelled smooth to an approved surface. All plaster work shall be kept continuously wet for seven days.

4. The external plaster shall be of two coats on an overall thickness of minimum 20 mm. Preparations of walls to receive plaster work shall be the same as in internal plaster. Backing coat shall be 12 to 15 mm thick with cement mortar 1:5 and finishing coat shall be with cement mortar 1:3. Backing coats shall be combed on wet surface to form keys for finishing coat. All external plaster shall be waterproofed with approved water proofing powder added to cement in proportion of 1.5 Kg. to 50 Kg. of cement as per the manufacturers' instruction, for both the coats. Cost of waterproofing powder per Kg. shall be paid for separately.

5. For sand faced cement plaster, the finishing coat shall be in cement mortar 1:3, sand used shall be of selected colour, properly graded and washed so as to give a grained texture. Finishing plaster coat shall be 8 mm thick, uniformly applied and surface finished with special rubbing by sponge pads and other tools and recommended by the Architect/PMC/ENGINEER-IN-CHARGE .

6. For rough cast plaster, the backing shall be floated with 3 mm thick cement mortar 1:4 with fine sand, spread in small areas not exceeding 2 Sq.mt. at a time. While this coat is still wet, the rough cast containing a mixture of 1 part of cement, 2 parts of fine sand and 1 part of gravel, 3 to 6 mm size, shall be dashed on the floating coat, to a uniform thickness of 15 mm thick and finished even.

9.3 WHITE WASHING

1. WHITE WASHING WITH LIME

The wash shall be prepared from fresh stone lime (Narnaul/Satna or Dehradun quality). The lime shall be thoroughly slaked on the spot, mixed and stirred with sufficiencies to water to make a thin cream. This shall be allowed to stand for a period of 24 hours and then shall be screened through a clean coarse cloth. 40 gm of gum dissolved in hot water, shall be added to each 10 entire delimiters of cream. The approximate quantity of water to be added in making ht cream will be 5 liters of water to 1 Kg. of lime.

Indigo (Neel) up to 3 gm. per Kg. of lime dissolved in water, shall then be added and wash stirred well. Water then shall be added at the rate of about 5 liters per Kg. of lime to produce a milky solution.

2. PREPARATION OF SURFACE

Before white washing is started, the surface shall be thoroughly brushed free from mortar droppings and foreign-matter. Any unevenness shall be made good by applying putty made of plaster of Paris mixed with water on the entire surface including filling up the undulations and then sand papering the same after it dry.

3. APPLICATION

The white wash shall be applied with moon brushes to the specified number of coats. The operation for each coal shall consist of a stroke of the brush given from top downwards, another from bottom upwards over the first stroke, and similarly one stroke horizontally from the right and another from the left before it dries up.

4. RATE

The rate shall include cost of all materials and labour involved in all the operations described above including scaffolding, protecting doors, windows, floor etc. from splashes and dropping.

9.4 WHITE WASHING WITH WHITING

Preparation of mix: Whiting (ground white chalk) shall be dissolved in sufficient quantity of warm and thoroughly stirred to form thin slurry which shall then be screened through a clean coarse cloth. Two Kg. of gum and 0.4 Kg. of copper sulphate dissolved separately in hot water shall be added for every cum of the slurry which shall then be diluted with water to the consistency of milk also as to make a wash ready for use.

Other specifications described in above shall be applied in this case also.

10. METAL WORKS

10.1 SCOPE OF WORK

The work covered by this specification consists of supply, fabrication and erection of steel components in accordance with the specifications and applicable drawings.

10.2 MATERIAL SPECIFICATIONS

All mild steel used in this work shall be of standard sections as marked on the drawings and shall be free of scale, blisters, laminations, cracked edges and defects of any sort.
Wherever specified mild steel shall be hot dip galvanized with Zinc coating containing not less than 97.5 percent pure zinc conforming to IS 1477-1977 (Part I & II) and shall be fixed or inserted as shown or directed.

10.3 WORKMANSHIP

All work shall be carried out as per drawing in a neat and good craftsman like manner by experienced and specially skilled workmen.

All embedded parts of structural steel shall be painted with anti corrosive bituminous paint as per manufacturer's specification unless otherwise specified and exposed surfaces shall be painted as specified or as directed.

10.4 MEASUREMENTS TO BE CHECKED

The Contractor shall obtain all relevant measurements at the site and with surrounding works and make necessary adjustments in the drawings, if required to suit actual site conditions to the approval of the Engineer before commencing fabrication.

10.5 ASSEMBLY

Work carried out in sections shall be carefully assembled. All members shall be secured together or to the anchors by welding or as shown in the details. All welds shall be ground smooth and made to match surrounding surfaces and finished to the satisfaction of the Engineer.

10.6 SETTING IN LEAD

Where specified, the member shall be embedded by setting in lead. In exterior locations, the end of the main structural support near the point of embedding shall be cleaned and covered with a solder and a bronze sleeve or umbrella shall be set on the steel upright to cover the joint and sealed by blow lamp.

10.7 RAILING, BALUSTERS AND NEWELS

1. SCOPE OF WORK AND GENERAL
   The item refers to supplying and fixing in position composite hand railing for staircase, open area, balcony, corridor etc. at different floors, levels and locations.

2. MATERIALS
   The class and quality of Wood, Mild Steel, Stainless Steel to be used for hand railing and workmanship shall comply with the requirements specified in relevant sections, trade practices and IS Specifications. Stainless steel shall of grade 304.

3. SAMPLES
   Before taking up fabrication and erection on mass scale, the sample of railing materials being used etc. shall be got approved by the Engineer-in-charge .

4. FABRICATION
   The fabrication of wooden handrail shall follow the standard specification for woodwork. The wooden handrail shall be in single piece per flight panel, moulded, shaped and finished to required dimensions as shown in drawing and as directed by the Engineer-in-charge . The hand railing shall be secured perfectly to line, slope and level to M.S./S.S. flat runners, balusters, and posts. M.S./S.S. grill, balusters, M.S./S.S. flat frame work fabricated as per the drawing and shall be strictly according to the specifications / trade practices.

5. FIXING/ERECTION
   M.S./S.S. Balusters, newels, posts, M.S./S.S. flat frame work manufactured as per drawing and as per approved sample, shall be firmly fixed in the pockets left for fixing of balusters or weld to main steel of waist slab or landing slab or weld to the inserts left for fixing of balusters. posts etc. as shown in the drawing. Necessary cover plates at the base of the balusters shall be provided after grouting the balusters duly kept in position. The hand railing shall follow the

inclination of stair in case of staircase and shall be perfectly in line, level and plumb for all other railings. Any damage caused to treads/risers while fixing of balusters, posts, railings etc., the damaged tread and riser shall be removed and replaced by new ones at no extra cost. Railing shall be joined in lengths with plain butt joints dowelled and held together by hand rails, bolts, clamps and M.S/S.S. frame work.

6. MODE OF MEASUREMENT

Hand railing shall be measured, for payment in running meters unless otherwise specified. The length shall be measured along the top centre line of the hand rail and shall be measured between ends of balusters, newels posts as the case may be up to two places of a decimal. Rate to include fabrication. leaving suitable pockets, grouting the same, fixing. all labour, materials, transporting, painting, polishing, finishing, scaffolding if necessary and as described in the schedule of quantities.

10.8 FENCING WORKS WITH WIRE, CHAIN LINK ETC.

The work shall generally be carried out as per these specifications, relevant drawings and as directed by the Engineer.

10.9 M.S. POSTS AND STRUTS

All the M.S. posts / struts shall be free from rust, scale, cracks, twists and other defects and shall be fabricated to the required shape and size out of the specified sections. The posts and strata shall be conforming to relevant specifications stipulated here-in-before under relevant sections. All the posts and strata shall be of sizes and lengths as specified in the tender schedule and drawing. The posts and strata shall have splits ends for proper fixing and shall be embedded in the cement concrete of mix 1:3:6 or as specified in schedule. The exposed surfaces of the posts and struts shall be painted with two coats of synthetic enamel paint of approved make and shade over a coat of approved primer.

1. SPACING OF THE POSTS AND STRUTS

The spacing of the posts shall be 3m centre to centre unless specified or as directed by the Engineer to suit the dimensions of the area to be fenced. Every 10th post, end posts, corner posts, and posts where the level of fencing changes in steps and end post when the fencing changes its direction shall be strutted on both sides, or as directed by the Engineer. End posts where barbed wire fencing is discontinued shall be strutted on one side only.

2. FIXING OF M.S./R.C.C. POSTS AND STRUTS

Pits of size 45 x 45 x 60 cm deep or of sizes mentioned in drawings, shall first be excavated centrally in the direction of proposed fencing work, true to line and level to receive the posts. In case of strata, the pits shall be as excavated, as to receive minimum 35 cm. Concrete cover at any point of the struts to unit its inclination or as shown in the drawing.

The pits shall be filled with a layer of 35 cm. Thick cement concrete of specified mix. The posts and struts shall then be placed in the pits, the posts projecting to the specified height above ground level, true to line, plumb and position by providing adequate supports temporarily, and cement concrete of specified mix shall then be filled in so that the posts are embedded in cement concrete blocks of specified sizes. The concrete in foundation shall be watered for at least 7 days to ensure proper curing.

10.10 GI CHAIN LINK / BARBED WIRE

GI chain link shall be of size 75 x 75 mm, 10 gauge and shall be fixed with the post with iron flats, nuts and bolts etc. in proper line and level. The barbed wire shall conform to IS:278 and sizes shall be as specified in item.

A. M.S.GRILLS

1. GENERAL

The contractor shall submit shop drawings covering a" types of work under this specifications before manufacture. The drawing shall show a" dimensions, details of construction, installation relating to the adjoining work.

2. MATERIALS

All structural Steel shall conform to I.S. 226-1.963.sections for grills and shall be free from loose mill scales, rusts, pittings or any other defects affecting its strength and durability.

3. FABRICATION

The grill shall be fabricated to the design and pattern shown in the drawings. All joints shall be made in best workman like manner with slotting and welding as required to the specified size and shape. The edge of the M.S. flats shall be suitably mitred before welding to get the desired shape. The joints shall be filled to remove excess stay after welding. Screws, nuts, washers, bolts, rivets and any other miscellaneous fastenings, devices shall be of steel and shall be provided by the contractor.
Manufactured M.S. grills then be fixed in between the posts, balusters, M.S. frame work etc. to correct alignment. Any undulations, bends etc. found shall be rectified by the contractor at his own cost. The complete assembly of grill/railing so fixed shall be firm and there shall not be any lateral movements.

4. SAMPLES

Samples of grill and railings shall be submitted for approval of the Engineer-in-charge and to be got approved before taking up for mass fabrication.

5. INSTALLATION

The approved grills shall be fixed in position where specified and shown in drawings including in masonry walls, teakwood frames, hand railings etc. Any damages to walls, frames etc. caused during fixing the grills shall be made good by grouting with cement mortar/packing/repairing properly at the contractor's cost.

6. PAINTING

Painting shall be done as per the specifications specified under painting.

7. MODE OF MEASUREMENT

Actual area of M.S. grill manufactured and fixed in position shall be measured in square metre or kg. for payment.
The rate is to include the cost of all materials, labour, transporting, fabricating, installing, scaffolding if necessary, grouting etc. complete.

11. SPECIFICATIONS FOR ANODIZED ALUMINIUM WORK

11.1 GENERAL :

The work shall be carried out a per approved ARCHITECTURAL drawings as per instructions of ENGINEER-IN-CHARGE .Special dimensions or directions in these specifications / nomenclature of the items shall supersede all other instructions.

11.2 MATERIAL:

Inspection of Material and works: All materials brought to the site by the Contractor, for use in the work as well as fabricated work shall be subjected to inspection and approval by ENGINEER-IN-CHARGE , get necessary tests, carried out on materials and own at his own cost of the Contractor.

a) **Removal of Rejected Material / Works** : In case any material / works are rejected by the ENGINEER –IN – CHARGE the same shall be removed from the site within 48 hours failing which the same may be removed by the ENGINEER – IN- CHARGE at the risk and the cost of the Contractor.
b) **Manufacturer's Test Certificate :** The Contractor shall , if required by the ENGINEER-IN-CHARGE ,produce manufacturer's test certificate for any material or particular batch of material supplied by him . The test(s) carried out shall be as per relevant specifications / Indian Standard Code

11.3 APPROVAL OF SAMPLES:

The Contractor shall submit to the ENGINEER –IN –CHARGE shop drawing of all doors / windows / ventilators / glazing etc. along with samples of all the materials for approval and no work shall commence before such samples are approved. Samples of unanodised as well as anodized sections ,PVC/ Neoprene / EPDM gaskets ,hardware fittings and fixtures, glass screws etc. any other material work shall be supplied and samples will be retained as standards of materials and workmanship . The cost of the shop drawings and samples shall be borne by the CONTRACTOR.

11.4 ALUMINIUM SECTIONS:

1. The aluminium sections shall confirm to I.S. Designation HE 9 WP / HV 9 WP alloy with chemical composition and technical properties as per I.S.733 and I.S.1285. The aluminium section section shall confirm to the following parameters also.

   a) The minimum tensile strength shall be 19 kg f/mm
   b) The maximum allowable deviation in length from a straight line shall be 0.5 mm / metre
   c) The maximum allowable deviation from straight shall be one degree.
   d) The maximum permissible twist shall be 0.5 mm / metre.
   e) The maximum variation in flatness shall be not more than 0.125 x 25 width.

2. Aluminium sections manufactures by reputed companies like HINDALCO / Jindal shall be used but the unit weight of the section should be not less than the unit weight of various components as specified in the drawings or in the nomenclature of item of works. For any excess weight of section used nothing extra shall be paid. However weights of finished anodized sections shall be considered for payment.

11.5 FABRICATION :

1. All joints shall be accurately fabricated and behave like in appearance. The finished surface shall be free from visible defects.

2. All hardware used shall conform to the relevant I.S.I a specifications and sampled shall be got approved from the Engineer – in – Charge before actual use. Each openable window and ventilators shall have an anodized shall have an Anodized Aluminium handle and a stay door shall have handles, tower bolts, six lever brass mortise lock 70 mm size (Godrej) or equivalent with one side key arrangement and to be fixed with counter sunk machine screws. Handles, tower bolts etc. to be fixed with necessary nickel plated self tapping hardened steel screws.
3. All aluminium works shall be deemed to include in various items complete works including making arrangements for all fittings, fixtures etc. as directed and approved by Engineer- in-charge.
4. All doors, glazings etc. shall be made completely leak proof against water and air and for which no extra payment shall be made.
5. All aluminium works should provided for replacing damaged / broken glass pane without having to remove or damage any member of interior finishing materials.

11.6 ANODIZING :

1. All aluminium sections shall be anodized as per I.S. 7085. Anodizing to conform to I. S.1868 and shall be AC 15 grade with minimum thickness of 15 microns when measured as per I.S.6012.
2. The Contractor should satisfy himself by 100% checking in the factory that the thickness of the anodic coating is found to be minimum 15 microns. Testing shall be done for thickness at Contractor's cost. If any material is found sub-standard this shall be rejected by the Engineer – in-charge.
3. The anodized aluminium works shall conform to relevant I.S.Codes relating to materials,workmanship,fabrication,finishing,erection,installation etc. In this connection relevant I.S. Codes including no. 1868 I.S.733 ,I.S.1948 ,I.S.7085, I.S 6012,1285,I.S.740 are considered applicable by the ENGINEER –IN-CHARGE and shall be followed.
4. Protective paper tape shall be applied on the anodized sections before they are brought on site. Then protective paper tape shall be removed after installation is complete.

11.7 GLAZING :

1. All glass panes shall be retained within aluminium framing by use of exterior grade PVC/Neoprene/EPDM Gaskets. No water leakage shall occur on the interior even if water penetrates exterior neoprene gaskets. Gas edges shall be clean cut into exact size glass with chipped or damaged edge shall be rejected.

2. For doors, glass of 5.5mm thickness conforming to classification 'A'quality or selected quality of I.S. 2835, shall be used.

11.8 FIXING :

The screws used for fixing aluminium member shall be of nickel plated hardened steel (Nettle fold or equivalent) threads of machine screws used shall conform to requirements of I.S 4218.

11.9 PROTECTION AND CLEANING :

After the work is completed aluminium works including glass panes shall be washed with a suitable thinner and water to remove all marks and blemishes etc. in order to give a uniform clear appearance.

C. TECHNICAL SPECIFICATIONS

PLUMBING WORKS

C.TECHNICAL SPECIFICATIONS-PLUMBING WORKS

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C.TECHNICAL SPECIFICATIONS - PLUMBING WORKS

SECTION - 01 :: BASIS OF DESIGN

1. BASIS OF DESIGN

The Plumbing, Sanitary, Drainage & Fire Protection System for the project is designed keeping in view the following:

1.1 Requirement of adequate and equal pressure availability of cold & Hot water lines in Toilets, Pentry/Kitchen and Cold makeup water supply etc.

1.2 Adequate storage of water in under ground raw + treated domestic water tanks.

1.3 Provision of fire fighting appurtenance such as sprinklers, fire hydrants, hose reel, and portable extinguishers.

1.4 Levels of roads / pavements and other services in the area.

1.5 Landscape layout.

The execution of works and materials used shall be as per the latest relevant I.S. specifications.

The extension of work shall in stick compliance to the Enviromental Clearance granted by MoEF, Govt. of India & NOC issued by Fire Department.

Wherever reference has been made to Indian Standard or any other specifications, the same shall mean to refer to the latest specification irrespective of any particular edition of such specification being mentioned in the specifications below or Schedule of Quantities.

2. CONCEPT OF THE SYSTEM

The following services are envisaged for the complex:

2.1 Water Treatment System for meeting the domestic water quality requirement with chemical parameters in acceptable limits as per SP:35(S & T) 1987 which is considered safe for human consumption, and other standards such as IS 10392 for boiler feed water quality.

2.2 Domestic (Cold) & Hot water supply through Hydropnumatic System for making water available at the residual pressure 1.5 to 2.0 kg / sq.cm.

2.3 Sewage and Sullage collection system based on IS: 1742 and applicable standards for domestic drainage.

2.4 Sewage / Effluent Treatment Plant comprising of ADBR technology treatment for recycling of the effluent. The treated effluent shall be used for flushing water required and for make-up to the cooling tower of air conditioning and of DG sets, scrubber and for gardening / irrigation purpose.

2.5 Storm / Rain water drainage system from various levels of the building and disposal to available municipal storm water disposal.

2.6 Fire Fighting system for the Complex comprising of Hydrant, Hose Reels, Sprinklers and portable fire extinguishers.

3. WATER STORAGE & DISTRIBUTION SYSTEM

3.1 Water Requirement

The water requirement for the project is proposed to be based on the provisions of IS:1172 and prevalent practice. The estimated requirement of water per day for the Complex is based on the number of users and other services.

3.2 Source of Water

It is expected that part of the daily domestic water requirement for the Complex shall be through borewell / municipal mains supply. Since it is unlikely that municipality would be able to meet the entire daily requirement, supply will have to be supplemented by having provision of adequate number of tube wells. Provision of tanker water fill feasibility shall also be made.

3.3 Water Storage

The static storage for Fire Protection is at present sized for 150 KL.

3.4 Water Quality

Domestic Water Requirement: The total domestic water shall be passed through basic water treatment plant and further specialized treatment shall be done based on the water analysis report and requirement. The basic water treatment plant shall comprise of MG filter, Softener and Hypo dosing.

Disinfected Water: It is proposed to provide localized UV units for water consumption points for direct consumption in Kitchen / Pantry.

Soft Water: Provision of polishing softener shall be made for feed water requirement of hot water generators and steam boilers. This feed water chemical parameters shall be as detailed in IS-20392.

Recycled Water from STP: Water recovered from tertiary sewage treatment plant shall be used as flushing water supply through separate storage tank and pumping system and shall also be used as make-up water in Air Conditioning and DG cooling towers, for wet scrubbers and for external landscape irrigation.

3.5 Water Distribution

The water distribution for cold & hot water supply for the Complex shall be designed on principle of zoning to ensure availability of adequate residual head at user outlet. Provision of pressure reducing station and non-return valve shall be made for effective and efficient water distribution in the Complex. Design is such that the cold & hot water pressure and flow shall be fairly equal to avoid reversal of flow from one service to another. Variable speed hydropematic system shall be provided fully equipped with pre-charged, non-toxic food grade bladder. Separate direct connection from header shall be taken for water requirement of Kitchen/Pentry etc.

3.6 Appurtenant

Following components shall be included in the water supply system for efficient functioning:

i. Automatic air vent at each of the high point.
ii. Drain valve at each of the low point.
iii. Pressure Release valve where abnormally high pressure is to be reduced.

iv. Water Hammer Arrestors (as required).
v. Flow meter.
vi. Pressure Gauge.
vii. Anchor block / thrust block.

4. SEWAGE, SULLAGE AND STORM WATER

The soil and waste shall be carried down in separate independently vented pipes. Two pipe drainage systems shall be adopted as per NBC (Part-IX). Provision of ASP vertical vent shall also be made for hygiene, safety consideration and to avoid foul smell entering through trapped gully in WC. Provision of grease trap shall be made for waste water from Kitchen.

4.1 Design Limitations

The system is designed considering the following:

1. High thrust developed at soil & water pipe connections.
2. Termination of vent cowl at terrace level.
3. Provision of adequate slope for horizontal header pipes for achieving self-cleaning velocity in the pipes.
4. Provision of cleanout plug.

5. WORKMANSHIP

The workmanship shall be best of its kind and shall conform to the specifications, as below or Indian Standard Specifications in every respect or latest trade practices and shall be subject to approval of the Owner's Site Representative. All materials and/or Workmanship which in the opinion of the Owner's Site Representative / Architect / Consultant is defective or unsuitable shall be removed immediately from the site and shall be substituted with proper materials and/or workmanship forthwith.

6. MATERIALS

All materials shall be best of their kind and shall conform to the latest Indian Standards. All materials shall be of approved quality as per samples and origins approved by the Owner's Site Representative / Architect / Consultants.

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

SECTION - 02 :: SANITARY FIXTURES & FITTINGS

1. SCOPE

The scope of this section consists of but is not necessarily limited to supply, installation, testing and commissioning of following items:

a. Sanitary appliances and fixtures for toilets.

b. Chromium plated brass fittings

c. Stainless steel sinks

d. Accessories e.g. towel rods, toilet paper holders, soap dish, liquid soap dispensers, towel rails, coat hooks etc.

e. Hand driers, drinking water fountains etc.

Whether specifically mentioned or not the Contractor shall provide for all appliances and fixtures all fixing devices, nuts, bolts, screws, hangers as required.

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

2. GENERAL REQUIREMENT

Sanitary appliances and fixtures for toilets, chromium plated brass fittings, stainless steel sinks, bathroom accessories like towel rods, toilet paper holders, soap dish, liquid soap dispensers, towel rails coat hooks etc and mirrors, hand driers, drinking water fountains etc as listed in the relevant items in the Schedule of Quantities shall be procured by the contractor.

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

The sanitary fixtures and fittings shall be installed at the correct assigned position as shown on the drawings and as directed by the Architect / Owner's Site Representative and shall fully meet with the aesthetic and symmetrical requirements as demanded by the Architect / Interior Designer

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

Fixing screws shall be half round head chromium plated (CP) brass screws, with CP brass washers unless otherwise specified.

Fixtures shall be installed by skilled workman with appropriate tools according to the best trade practice.

All appliances , fittings and fixtures shall be fixed in a neat workmanlike manner true to level and to heights shown on the drawings and in accordance with the manufacturers 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, plaster, paint, insulation or terrace shall be made good by the Contractor at his own cost. Fixtures shall be mounted rigid, plumb and true to alignment.

All materials shall be rust proofed; materials in direct or indirect contact shall be compatible to prevent electrolytic or chemical (bimetallic) corrosion.

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

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

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

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

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

iv. The appliance shall be securely fixed. Manufacturer's brackets and fixing methods shall be used wherever possible. Compatible rust-proofed fixings shall be used. Fixing shall be done in a manner that minimizes noise transmission.

v. Appliances shall not be bedded (e.g. WC pans, pedestal units) in thick strong mortar that could crack the unit (e.g. ceramic unit)

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

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

Sizes of sanitary fixtures given in the Specifications or in the Schedule of Quantities are for identification with reference to the catalogues of make considered. Dimensions of similar models of other makes may very within $\pm$ 10% and the same shall be provided and no claim for extra payment shall be entertained NOR shall any payment be deducted on this account.

The contractor shall fix all plumbing fittings such as water faucets, shower fittings, mixing valves etc. in accordance with manufacturer's instructions and connect to piping system. The contractor shall supply all fixing materials such as screws, rawl plugs, unions, collars, compression fittings etc., as required.

Joints / gaps between all sanitary appliances / fixtures and the floor / walls shall be caulked with an approved mildew resistant sealant, having antifungal properties, of colour and shade to match that of the appliances / fixture and the floor / wall to the extent possible.

2.1 Water Closet

Water Closet shall be wash down or symphonic wash down type floor or wall mounted set, as shown in the drawings, designed for low volume flushing from 3-6 litres of water, flushed by means of a porcelain flushing cistern or an exposed or concealed type (as detailed in the drawings or as directed by the Owner's Site Representative). Flush pipe / bend shall be connected to the WC by means of a suitable rubber adaptor. Wall hung WC shall be supported by CI floor mounted chair which shall be fixed in a manner as approved by the Owners Site Representative.

Each WC set shall be provided with approved quality of seat, rubber buffers and chromium plated hinges. Seat shall be so fixed that it remains absolutely stationary in vertical position without falling down on the WC.

Each WC shall be provided with 110 mm dia (OD) PVC Pan connector connecting the ceramic outlet of WC to CI pipe.

2.2 Urinals

Urinals shall be lipped type half stall with glazed vitreous China of size as called for in the Bill of Quantities.

Half stall urinals shall be provided with 15mm dia CP spreader, 32mm dia CP domical waste and CP cast brass bottle trap with pipe and wall flange and shall be fixed to wall by CI brackets, CI wall clips and CP brass screws as recommended by manufacturer complete as directed by the Owner's Site Representative.

Flushing for urinals shall be by means of no hand operation, infrared electric flush valve with complete kit of plumbing, electrical and electronic items, infrared photo cells, solenoid valve transformer and electrical connection. The automatic flush sensor plate shall be flush and press fitted and be of high quality mirror polish finish. Each urinal shall be provided with one flush valve unit.

Flush pipes shall be GI pipes concealed in wall chase but with chromium plated bends at inlet and outlet.

Urinal Partitions

Urinal partitions shall be white glazed vitreous china of size specified in the Schedule of Quantities.

Porcelain partitions shall be fixed at proper heights with CP brass bolts, anchor fasteners and MS clips as recommended by the manufacturer and directed by the Owner's Site Representative.

2.3 Cisterns

Low level flushing cistern (exposed or concealed) shall be provided for WC in specified toilets. Contractor shall install cistern in accordance to the manufacturer's specification to the satisfaction of the Owner Site Representative.

2.4 Wash Basin

Wash basins shall be white glazed vitreous china of size, shape and type specified in the Schedule of Quantities.

Each basin shall be provided with painted MS angle or CI brackets and clips and the basin securely fixed to wall/counter slab. Placing of basins over the brackets without secure fixing shall not be accepted. The MS angle shall be provided with two coats of red oxide primer and two coats of synthetic enamel paint of make , brand and colour as approved by the Owner's Site Representative. The cost of fixing the basin shall be inclusive of supply and installation of brackets as described above.

Each basin shall be provided with 32mm dia CP waste with overflow, pop-up waste or rubber plug and CP brass chain as specified in the Schedule of Quantities.

Each basin shall be provided with hot and cold water mixing fitting or as specified in the Schedule of Quantities.

2.5 Sinks

Sinks shall be stainless steel or any other material as specified in the Schedule of Quantities.

Each sink shall be provided with painted MS or CI brackets and clips and securely fixed. Counter top sinks shall be fixed with suitable painted angle iron brackets or clips as recommended by the manufacturer. Each sink shall be provided with 40mm dia CP waste and rubber plug with CP brass chain as given in the Schedule of Quantities. The MS angle shall be provided with two coats of red

oxide primer and two coats of synthetic enamel paint of make, brand and colour as approved by the Owner's site representative.

Sanitary fittings for sinks shall be deck mounted or wall mounted CP swivel faucets with or without hot and cold water mixing fittings as specified in the Schedule of Quantities. Installation of fittings shall be measured and paid for separately.

2.6 Shower Set

Shower set shall comprise of two CP brass concealed stop cocks, four/five way auto-diverter, adjustable type over-head shower with CP shower arm , all with CP wall flanges of approved quality all as specified in the Schedule of Quantities. Bath spout, hand showers and pop up wastes shall also be provided wherever, specified. Wall flanges shall be kept clear off the finished wall. Wall flanges embedded in the finishing shall not be accepted.

2.7 Flow Control Device

Approved / rated flow control fitment in brass body, chrome outer cover, rated for flow / discharge of the fixture.

2.8 Toilet Paper Holder

Toilet paper holder shall be white glazed vitreous china or chrome plated of size, shape and type specified in the Schedule of Quantities.

Porcelain toilet paper holder shall be fixed in walls and set in cement mortar 1:2 (1 cement: 2 coarse sand) and fixed in relation to the tiling work.

The latter (chrome) shall be fixed by means of screws/capping having finish similar to the toilet paper holder in wall/temper partitions with raw l plugs or nylon sleeves. When fixed on timber partition, it shall be fixed on a solid wooden base member provided by the Owner's Site Representative.

2.9 Towel Rail

Towel rail shall be chromium plated brass or of stainless steel or powder coated brass of size, shape and type specified in the Schedule of Quantities.

Towel rail shall be fixed with screws/capping having finish similar to the towel rail in wall with rawl plugs or nylon sleeves and shall include cutting and making good as required or directed by the Owner's Site Representative.

2.10 Janitor's Sink

Janitor's sink shall be stainless steel, single bowl type of size as called for in the Schedule of Quantities , provided with painted R.S. or CI brackets and clips and securely fixed. Each sink shall be provided with 40mm dia CP waste. Fixing shall be as directed by the Owner's Site Representative.

The supply fittings for Janitor's sink shall be wall mounted type of size as mentioned in Schedule of Quantities.

2.11 Drinking Water Fountain

Drinking water fountain shall be well mounting type made of vitreous china, stainless steel or any other material as given in the Schedule of Quantities.

The drinking water fountain shall be with anti-squirt bubble less, self closing valve type with automatic volume regulator. The drinking water fountain shall be provided with an anti-splash back and integral strainer with 32mm or 40mm cast brass trap.

2.12 Liquid Soap Dispenser

Liquid Soap Dispenser shall be wall/counter mounted suitable for dispensing liquid soaps, lotions, detergents. The cover shall lock to body with concealed locking arrangement, opened only be key provided.

Liquid soap dispenser body and shank shall be of high impact resistance material. The piston and spout shall be stainless steel with 1 litre capacity polyethylene container.

The valve shall operate with less than 2.27 Kg (5 lbs) of force.

2.13 Hand Drier

The hand drier shall be no touch operating type with solid state time delay to allow user to keep hand in any position.

The hand drier shall be fully hygienic, rated for continuous repeat use (CRU).

The rating of hand drier shall be such that time required to dry a pair of hands up to wrists is approximately 30 seconds.

The hand drier shall be of wall mounting type suitable for 230 V, single phase, 50 Hz, AC power supply.

3. TOILETS FOR THE DISABLED

Where specified, in washroom facilities designed to accommodate physically disabled, accessories shall be provided as directed by the Owner's Site Representative.

Stainless steel garb brass of required size suitable for concealed or exposed mounting and opened non-slip gripping surface shall be provided in all washroom. The flushing cistern/valve shall be provided with chromium plated long handles.

4. MOCKUP AND TRIAL ASSEMBLY

The installation of the Sanitary fixtures and fittings shall be as per the shop drawings approved by the Architect/Consultant.

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

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

5. SUPPORTING AND FIXING DEVICES

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

6. FINAL INSTALLATION

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

Fixtures shall be mounted rigid, plumb and to alignment. The outlets of water closet pans and similar appliances shall be examined to ensure that outlet ends are butting on the receiving pipes before making the joints. It shall be ensured that the receiving pipes are clear of obstruction. When fixtures are being mounted, attention shall be paid to the possibility of movement and settlement by other causes. Overflows shall be made to ensure that necessary anchoring devices have been provided for supporting water closets, wash basins, sinks and other appliances.

7.PROTECTION AGAINST DAMAGE

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

8.MEASUREMENT

8.1 Rate for fixing only of sanitary fixtures accessories, CP fittings shall etc. include all items, and operations stated in the respective specifications and bill of quantities and nothing extra is payable.

8.2 Rates for all items under specifications para above shall be inclusive of cutting holes and chases and making good the same, CP screws, nuts, bolts and any fixing arrangements required and recommended by manufacturers, testing and commissioning and making good to the satisfaction of the Owner's Site Representative.

9.TESTING

All appliances, fixtures and fittings shall be tested before and after installation. Water seals of all appliances shall be tested. The contractor shall block the ends of waste and ventilation pipes and shall conduct an air test.

SECTION - 03 :: WATER SUPPLY (COLD)

1. SCOPE

The scope of this section comprises the supply, installation, testing and commissioning of piping network for water supply for internal & external services as follows:

a Bore well / Municipal / Tanker Water supply.

b. Drinking Water Supply.

c. Flushing Water Supply

d. Washing

e. External water supply to cater for Horticulture and Cooling Towers drawn from the Treated Sewage Water Tank through an independent pumping System (as required).

f. Connection to various mechanical equipments to be supplied and installed by the other specialist contractors.

The Contractor shall make all necessary application and arrangements for his work to be inspected by the Local Authorities.

The Contractor shall be solely responsible for obtaining the Authorities approval of his works prior to the handing over of the complete water supply / distribution installation to the Owner.

2. PIPING MATERIALS

The piping system shall consist of CPVC SDR 11.0 piping from 15 mm to 50 mm & Schedule 40 from 65 mm to 150 mm for cold water supply & schedule 80 from 65 mm to 150 mm for hot water supply.

The piping system shall also consist of heavy class galvanized iron pipes and fittings conforming to IS:1239. The sizes and makes is specified in the Schedule of Quantities.

For any internal works, the CPVC pipes / galvanized iron pipes and fittings shall be embedded in the wall chase or run on the floor/ceiling unless otherwise specified. No unsightly exposed runs shall be permitted.

A. <u>CPVC Pipes & Fittings</u>

The pipes shall be CPVC (Chlorinated Poly Vinyl Chloride) material for hot & cold water supply piping system with pipes as per CTs SDR -11 at a working pressure of 320 PSI at 23 deg C and 80 PSI at 82 deg.C, using solvent welded CPVC fittings i.e. Tees, Elbows, Couples, Unions, Reducers, Brushing etc. including transition fittings (connection between CPVC & Metal pipes / GI) i.e. Brass adapters (both Male & Female threaded and all conforming to ASTM D-2846 with only CPVC solvent cement conforming to ASTM F-493, with clamps / structural metal supports as required /directed at site including cutting chases & fitting the same with cement concrete / cement mortar as required, including painting of the exposed pipes with one coat of desired shade of enamel paint. All termination points for installation of faucets shall have brass termination fittings. Installation shall be to the satisfaction of manufacturer & Project Manager. Pipes from 65 mm to 150 mm dia shall be Schedule 40 for CWC & Schedule 80 for HWS / HWR.

i). **Joining Pipes & Fittings**

1. Cutting: 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.

2. Deburring / Beveling: Burrs and fittings should be removed from the outside and inside of pipe with a pocket knife or file otherwise burrs and fittings may prevent proper contact between pipe and fittings during assembly.

3. Fitting preparation: A clean dry rag/cloth should be used to wipe dirt and moisture from the fitting sockets and tubing end. The tubing should make contact with the socket wall 1/3 or 2/3 of the way into the fitting socket.

4. Solvent Cement Application: Only CPVC solvent cement confirming to ASTM-F493 should be used for joining pipe with fittings. An even coat of solvent cement should be applied on the pipe end and a thin coat inside the fitting socket, otherwise too much of cement solvent can cause clogged water ways.

5. Assembly: 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 bed of cement should be evident around the joint and if this bed is not continuous then remake the joint to avoid potential leaks.

   Set & Cure times: Solvent cement set and cure times shall be strictly adhered to as per the below mentioned table.

   Minimum Core prior to pressure testing at 150 PSI

Ambient Temperature during Core period	**Pipe Size**	
	½ " - 1"	**1.¼" - 2"**
Above 15 deg. C	1 Hr	2 Hrs
4-15 deg.C	2 Hrs	4 Hrs
Below 4 deg C	4 Hrs	8 Hrs

   Special care shall be exercised when assembling flow guard systems in extremely low temperature (below 4°C) or extremely high temperature (above 45°C) In extremely hot temperatures, make sure that both surfaces to be joined are till wet with cement solvent when putting them together.

6. Testing

   i. Once an installation is completed and cored as per above mentioned recommendations, the system should be hydrostatically pressure tested at 150 psi(10 Bar) for one hour. During pressure testing, the system should be fitted with water and if a leak is found, the joint should be cut out and replacing the same with new one by using couplers.

   ii. Transition of Flow guard CPVC to Metals

   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. Threaded Sealants

Teflon tape shall be used to make threaded connections leak proof.

iv. Solvent Cement

Only CPVC solvent cement conforming to ASTMF 493 should be used for joining pipe with fittings and valves. Flow guard CPVC cement solvent have a minimum shelf life of 1 year. Aged cement solvent will often change colour or being to thicken and become gelatinous or jelly like and when this happens, the cement should not be used. The cement solvent should be used within 30 days after opening the company's seal and tightly close the seal after using in order to avoid its freezing. The freezed cement solvent should be discarded immediately and fresh one should be used. The CPVC solvent cement usage should be adhered to as given in table below

Diameter of pipe in inch (flow guard)	½"	¾"	1"	¼"	1½"	2"
Approx. nos. of joints which can be mode per litre of solvent cement.	200 Nos	180 Nos	150 Nos	130 Nos	100 Nos	70 Nos

v. Hangers and supports

For Horizontal runs, support should be given at 3 foot (90 cm) intervals for diameters of one inch and below and at 4 foot (1.2m) intervals for larger sizes. Hangers should not have rough or sharp edges which come in contact with the tubing.

Supports should be as per the below mentioned table:

Size of Pipe	**21°C**	**49°C**	**71°C**	**82°C**
Inch	**Ft.**	**Ft.**	**Ft.**	**Ft.**
½"	5.5	4.5	3.0	2.5
¾"	5.5	5.0	3.0	2.5
1"	6.0	5.5	3.5	3.0
1¼"	6.5	6.0	3.5	3.5
1½"	7.0	6.0	3.5	3.5
2"	7.0	6.5	4.0	3.5

SCHEDULE - 40							
Recommended Support spacing (in feet)							
Nom. Pipe Size		**Temperature ºC**					
(In)	**(mm)**	**23**	**38**	**49**	**60**	**71**	**82**
2 ½	65	7 ½	7	7	6 ½	6	3 ½
3	80	8	7	7	7	6	3 ½
4	100	8 ½	7 ½	7 ½	7	6 ½	4
6	150	9 ½	8	8	7 ½	7	4 ½
8	200	9 ½	8	8	7 ½	7	5

SCHEDULE - 80
Recommended Support spacing (in feet)

Nom. Pipe Size		Temperature °C					
(In)	(mm)	23	38	49	60	71	82
2 ½	65	8	7 ½	7 ½	6 ½	4 ½	4
3	80	8	8	7 ½	7	4 ½	4
4	100	9	9	8 ½	7 ½	5	4 ½
6	150	10	9 ½	9	8	5 ½	5

B. Galvanised Iron Pipes & Fittings

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

The fittings shall be malleable iron and comply with all the requirements of the pipes. The size of pipes and fitting is specified in the schedule of quantities.

Laying And Jointing Of GI Pipes

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

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

2.1 HIGH DENSITY POLYETHYLENE (HDPE) PIPES

2.1.1 Specifications

Wherever specified, High Density Polyethylene (HDPE) pipes for water supply and landscape irrigation shall conform to IS : 4984-1987 (Material Grade PE-80) and be of appropriate pressure rating.

The pipes shall be reasonable round and shall be supplied in straight lengths with socketed or plain ends as specified. The internal and external surfaces of the pipes shall be smooth and clean, free from grooving and other defects.

Properties	Specification	Unit	

Density at 27°C	BIS-7328-1974	gm/cm²	0.9425-0.9524
MFR	BIS-7328-1974	gm/10min	0.4 to 1.1
Viscosity Number	ISD/R-1191	dl/g	300
Ultimate Tensile Strength	ISD/R-527	kgf/cm²	350
Elongation at break	BIS-7328-1974	%	800
Notched Impact Strength	DIN 53453	Kgf/cm²	10
Coefficient of Linear Expansion between 20° and 90°C	DIN 52328	deg-c-1	2×10^{-4}
Dielectric constant (relative) at 50-106 HZ	DIN 53483	-	2.4 – 2.5
Crystalline melting range		deg°C	128 – 132

Pressure Rating

Pipes are classified by pressure rating (PN) corresponding to the maximum permissible working pressure at 30°C, as follows:

Pressure Rating of Pipes	**Maximum Permissible working Pressure**
PN 2.5	0.25 MPa
PN 4	0.40 MPa
PN 6	0.60 MPa
PN 10	1.00 MPa
PN 12.5	1.25 MPa
PN 16	1.60 Mpa

Major Characteristics of HDPE Pipes

a. Pipe resins are always copolymers. The quantity and type of the added comonomer determine the stress crack resistance of the pipe.

b. Densities for pipe resins will generally be in the range of 935 to 950 Kg/m³.

c. MWD (Molecular Weight Distribution) will generally be broad.

d. Melt indexes are generally below 0.3.

2.2 Laying and Jointing

All excavation work for laying HDPE pipes shall be done as described in section 3.1 in general. However, the special care must be taken to ensure that the hard objects like stones, rock pieces, tree roots etc. are not present. Pipes shall be bedded in sand or soft soil free from rock and gravel. Backfill upto 15 cm above the pipe shall also be of fine sand or soft soil. Pipes shall not be painted. The width of the trench shall be outside diameter of the pipe plus 30 cm. Pipes shall be laid atleast 90 cm. below the ground level (measured from surface of the ground to the top of the pipe).

HDPE pipes shall be butt jointed by heat fusion method in accordance with the following procedures. HDPE pipes shall not be threaded. Jointing procedure shall be as follows and shall be

strictly adhered to obtain optimum quality of joints. skillful application of qualified technique, welder and the use of proper construction equipment in good condition shall be made to achieve sound joints in HDPE piping.

2.3 Preparation

Any kinks or buckles in pipe near its ends shall be removed by cutting out as a cylinder. The face of the joints to be welded shall be flat. Correct position and holding of pipe is necessary when sawing pipe to achieve this. For pipes 160 mm. OD and above, shaping tool may be used.

Whether pipes have been sawn or not, joint faces shall be slightly scrapped with a knife, prior to welding, to remove exposed layers which may lead to unsatisfactory joint. Both the sections of pipe to be welded shall be positioned by using rollers and/or wooden supports.

2.4 Welding

Butt heat-fusion joint procedure shall require the use of jointing device (welding jack) that holds the heat element (mirror) square to the ends of pipes, can compress the heated ends together and holds the piping in proper alignment while the plastic hardens.

Temperature of joints should be 200^{o} C. Surface temperature, of the heating mirror, must, therefore, be 210^{o} C $\pm$ 5^{o} C. The faces of pipes to be joined shall be on either sides of the heating mirror and maximum of 0.4 kg/cm^2 contact pressure shall be applied. Contact pressure should not exceed this, otherwise the molten mass from the joint faces will be squeezed out prior to welding. Even with the lowest pressure a rim of molten material shall be formed on the ends of pipes being joined. Care shall be taken in the heating operation to prevent damage to the plastic material from over heating or having the material not sufficiently heated to ensure a sound joint. Direct application of heat, with a torch or other open flame is prohibited.

Approximate heating for series IV pipe may be taken as:-

32 mm OD pipe	:	1 minute
75 mm OD pipe	:	3 minutes
160 mm OD pipe	:	5 minutes

Heating time for pipes with lesser wall thickness may be according to experience and ambient temperature prevailing. Completion of heating is indicated by formation of a uniform rim of molten material at the edges of pipes.

Subsequent to heating, the pipes shall be removed from the heating mirror and shall be immediately joined by application of moderate pressure for 2-3 seconds, after which, pressure of approximately 0.6 Kg/cm^2 shall be applied for two minutes. After two minutes the pressure shall be increased to 1.2 kg/cm^2 and sustained for pipes upto 160 mm OD and 30 minutes for pipes 225 mm OD and larger.

Care shall be taken that the rim formed during welding is not too large. Pressure shall be maintained until the joint is hand-warm. After relieving pressure joint shall be allowed to cool completely before handling.

The electric heating mirror used shall be specially designed to meet the requirements of HDPE pipe welding. It should have a proper regulator to control and maintain its temperature during the welding procedure. It shall have P.T.F.E. cloth fitted on both sides to prevent adhesion of molten polyethylene on surface of the mirror.

Jointing Methods

Butt Welding is the only permanent joint. Technically and economically, it is the best method.

Tools Required: Welding Jack, Heating Mirror and other tools for beveling & cleaning and Hacksaw for cutting.

1. Cut the pipe straight, bevel and clean the inner edge and align the cut surfaces of the pipes.
2. Heat the mirror to 200°C electrically with temperature controller or with a kerosene blow torch and test the mirror temperature with thermochrome chalk.
3. Press the cut surface of the pipes to the two sides of the heating mirror and let the weld rims form.
4. Remove the mirror and press the heated ends together till they are fused with each other to form a Fusion Ring.

The outer and inner diameters at the ends of an HDPE pipe are reduced by shrinkage during cooling if the pipe is cut while it is hot. It is desirable to cut the pipes to be joined about 30 cm after either end before butt welding.

Pipe End & Flange Joint, as the name suggests, consists of a pipe-end (collar) butt-welded to the end of the pipe to be joined, and a backing / slip-on flange. Two such pipe ends are placed face-to-face with a rubber gasket and the flanges are tightened with nuts and bolts. The flanges can be made of plastic or metal. Plastic coating of metal flanges prevents corrosion and ensures longer life for the joint.

Measurement:

a. Excavation: Measurement for excavation of pipes trenches shall be made per linear meter.

b. Trenches shall be measurement between outside walls of manholes at top and the depth shall be the average depth between the two ends to the nearest cm. The rate quoted shall be for a depth upto 1.5 metres or as given in the Bill of Quantities.

c. Payment for trenches more than 1.5m in depth shall be made for extra depth as given in the Bill of Quantities and above the rate for depth upto 1.5m.

d. HDPE pipes shall be measured for length of the pipe line per linear meter: Length between manholes shall be recorded from inside of one manhole or inside of other manhole.

3. PIPING INSTALLATION SUPPORT (VALID FOR GI PIPING ONLY)

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

Piping shall be properly supported on , or suspended from, on stands, clamps, hangers as specified and as required. The Contractor shall adequately design all the brackets, saddles, anchor, clamps and hangers, and be responsible for their structural stability.

Pipe work and fittings shall be supported by hangers or brackets so as to permit free expansion and contraction. All accessories and ancillaries of support system such as brackets, saddles, clamps, hangers

etc. shall be hot dip galvanized after fabrication. Further to permit free movement of common piping, support shall be from a common hanger bar, fabricated from galvanised steel sections.

Pipe hangers shall be provided at the following maximum spacings:

Pipe Dia (mm)	**Hanger Rod Dia (mm)**	**Spacing between Supports (m)**
Up to 25	6	2
32 to 50	10	2.7
80 to 100	12	2.7
125 to 150	16	3.6
200 to 300	19	5.3

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

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

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

Pipe sleeves, larger diameter than pipes, shall be provided wherever pipes pass through walls and slab and annular space filled with fiberglass and finished with retainer rings.
The contractor shall make sure that the clamps, brackets, saddles and hangers provided for pipe supports are adequate or as specified / approved by Consultants. Piping layout shall take due care for expansion and contraction in pipes and include expansion joints where required.

All pipes shall be accurately cut to the required sizes in accordance with relevant BIS codes and burrs removed before laying. Open ends of the piping shall be closed as the pipe is installed to avoid entrance of foreign matter. Where reducers are to be made in horizontal runs, eccentric reduces shall be used for the piping to drain freely. In other locations, concentric reduces may be used.

All buried pipes for CWS shall be cleaned and coated with two coats of bitumen and then wrapped with two layers of 400 micron polythene sheet coating.

Automatic air valves shall be provided at all high points in the piping system for venting. All valves shall be of 15mm pipe size and shall be associated with an equal size isolation ball valve. Automatic air valves shall also be provided on hot water risers.

Discharge from the air valves shall be piped through a galvanized steel pipe to the nearest drain or sump. All pipes shall be pitched towards drain points.

Pressure gauges shall be provided as shown on the approved drawings and include in Bill of Quantities. Care shall be taken to protect pressure gauges during pressure testing.

Temperature gauge as specified shall be provided at the hot water supply and return and as shown on drawings and included in Bill of Quantities.

4. FERRULES

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

4.1 Fixing Ferrules

For fixing ferrule in cast iron mains, the empty main shall be drilled and tapped at 45 deg to the vertical and the ferrule screwed in. The ferrule must be so fitted that no portion of the shank shall be left projecting within the main into which it is fitted.

5. WATER METERS

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

The meters shall conform to Indian Standard IS:779 and IS:2373. Calibration certificate shall be obtained and submitted for each water meter.

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

5.1 Installation Of Water Meter And Stop Cock

The G.I. lines shall be cut to the required lengths at the position where the meter and stop cock are required to be fixed. Suitable fittings shall be attached to the pipes. The meter and stop cock shall be fixed in a position by means of connecting pipes, jam nut and socket etc. The stop cock shall be fixed near the inlet of the water meter. The paper disc inserted in the ripples of the meter shall be removed. And the meter installed exactly horizontal or vertical in the flow line in the direction shown by the arrow cast on the body of the meter. Care shall be taken that the factory seal of the meter is not disturbed. Wherever the meter shall be fixed to a newly fitted pipe line, the pipe line shall have to be completely washed before fitting the meter.

6. TESTING

The Contractor shall notify the Architect three days in advance of any test so that the Architect can witness the tests if he so wishes.

All water supply system shall be tested to hydrostatic pressure test of at least one and a half (1.5) times the maximum pressure but not less than 10Kg/Sq.cm for a period of not less than 8 hours. All leaks and defects in joints revealed during the testing shall be rectified and got approved at site by retest. Piping required subsequent to the above pressure test shall be retested in the same manner.

System may be tested in sections and such sections shall be entirely retested on completion.
The Contractor shall make sure that proper noiseless circulation of fluid is achieved through the entire piping network of the system concerned. In case of improper circulation, the contractor shall rectify the defective connections. He shall bear all expenses for carrying out the above rectifications including the tearing up and refinishing of floors and walls as required.

In addition to the sectional testing carried out during the construction, contractor shall test the entire installation after connections to the overhead tanks or pumping system or mains. He shall rectify all leakages and shall replace all defective materials in the system. Any damage done due to carelessness, open

or burst pipes or failure of fittings, to the building, furniture and fixtures shall be made good by the contractor during the defects liability period without any cost.

After commissioning of the water supply system, contractor shall test each valve by closing and opening it a number of times to observe if it is working efficiently. Valves which do not effectively operate shall be replaced by new ones at no extra cost and the same shall be tested as above.

A test register shall be maintained and all entries shall be signed and dated by Contractor(s) and Owner's site representative.

7. DISINFECTION OF PIPING SYSTEM AND STORAGE TANKS

Before commissioning the water supply system, the contractor shall arrange to disinfect the entire system as described in the succeeding paragraph.

The water storage tanks and pipes shall first be filled with water and thoroughly flushed out. The storage tanks shall then be filled with water again and disinfecting chemical containing chlorine added gradually while tanks are being filled to ensure thorough mixing. Sufficient chemical shall be used to give water a dose of 50 parts of chlorine to one million parts of water.

If ordinary bleaching powder is used, the proportions will be 150 gm of power to 1000 liters of water. The power shall be mixed with water in the storage tank. If a proprietary brand of chemical is used, the proportions shall be specified by the manufacturer. When the storage tanks is full, the supply shall be stopped and all the taps on the distributing pipes are opened successively working progressively away from the storage tank. Each tap shall be closed when the water discharged begins to smell of chlorine. The storage tank shall then be filled up with water from supply pipe and added with more disinfecting chemical in the recommended proportions. The storage tank and pipe shall then remain charged at least for three hours. Finally the tank and pipes shall be thoroughly flushed out before any water is used for domestic purpose.

The pipe work shall be thoroughly flushed before supply is restored.

8. STERILIZATION OF MAIN

After the pipe work has been tested and approved, but before it is coupled, it shall be sterilized with a solution of chloride of lime.

9. CUTTING CHASES IN MASONARY WALLS

Cold water distribution pipes to fixtures and equipment exposed to view in the bathrooms, kitchens, and sanitary compartments shall be chased into walls or floors or placed in wall cavities. The Contractor shall be responsible for cutting all notches, chases, and recesses in walls and floors and only a diamond cutter shall be used. The maximum size of conduit or pipe permitted to be concealed in floor slabs shall be 32 mm diameter unless otherwise approved by the Architect.

The chases upto 7.5 x 7.5 cm shall be made in the walls for housing GI pipes etc. These shall be provided in correct positions as shown in the drawings or directed by the Architects. Chases shall be made by chiselling out the masonry to proper line and depth. After the pipes etc are fixed in chases, the chases shall be filled with cement mortar 1:2:4 or as may be specified, and made flush with the masonr surface. The concrete surface shall be roughened with wire brush to provide a key for plastering.

Where pipes pass through beams or structural walls, subject to the approval of the Structural Consulting Engineer, the Contractor shall ensure that sizes and locations of openings required are formed in when the relevant beams or walls are cast.

10. VALVES

All valves (gate, globe, check, safety) shall be of gun metal suitable for the particular service as specified. All valves shall be of the particular duty and design as specified. Valves shall either be of screwed type or flanged type, as specified, with suitable flanges and non-corrosive bolts and gaskets. Tail pieces as required shall be supplied along with valves. Gate, globe and check valves shall conform to Indian Standard IS:776 and non-return valves and swing check type reflux to IS:5312.

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

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

Globe valves on Hot-water line shall be union bonnet with stem/disc and body seat ring of SS. Suitable for temperature upto 80° C.

S. No	Type of Valve	Size	Construction	Ends
a.	Isolating Valve	15 mm to 50 mm 65 mm and above	Gun Metal Gun Metal	Screwed Flanged
b.	Sluice Valve & Butterfly Valve	65 mm and above	Cast Iron	Flanged
c.	G.M. non return valve	15 mm to 50 mm 65 mm above	Gun Metal Gun Metal	Screwed Flanged
d.	Flap Type – Non return valve	65 mm and above	Cast Iron	Flanged

All valves shall be suitable for the working pressure involved.

10.1 Pressure Reducing Valve Set

Each pressure reducing valve set shall be complete with pressure reducing or pressure regulating valve, isolating valves, pressure gauges on inlet and outlet, pressure relief valve on outlet and filter on inlet.

Each pressure reducing valve shall contain loading neoprene diaphragm and a full floating, self aligning, ignition resistant seat and shall be of the single stage, pressure reduction type with provision for manually adjusting the delivery pressure. The valve shall fail safe to the low pressure.

Valves shall be capable of operating at the maintaining automatically the respective delivery pressure and flow rates as indicated and shall not be liable to creep. Valves shall also be capable of maintaining the pre-set down stream pressure under static condition.

The filter on each inlet to a pressure reducing valve shall be of replaceable porous sintered metal type.

10.2 Pressure Relief Valves

Each pressure relief valve shall be of the fully enclosed type and fitted with hand easing gear.

Each pressure relief valve in a pressure reducing station shall have a flow capacity equal to that of the pressure reducing valve.

Pressure relief valves in locations other than reducing stations shall have flow capacities equal to that of the associated equipment.

10.3 Pressure Gauge

The pressure gauge shall be constructed of die cast aluminium and stove enamelled. It shall be weather proof with an IP 55 enclosure. It shall be a stainless steel Bourden tube type pressure gauge with a scale range from 0 to 16 Kg / cm square and shall be constructed as per IS:3524. Each pressure gauge shall have a siphon tube connection. The shut off arrangement shall be by Ball Valve.

Calibration certificate shall be obtained and submitted for each pressure gauge.

11. WATER FITTINGS

Unless otherwise specified all Gunmetal fittings such as gate, globe, check & safety valves shall be fitted in pipe line in workman like manner. Necessary unions shall be provided on both ends of the valves for easy replacement. The joints between fittings and pipes shall be leak-proof when tested to desired pressure rating. The defective fittings and joints shall be replaced or redone.

12. CONNECTIONS TO VARIOUS MECHANICAL EQUIPMENT SUPPLIED BY OTHER AGENCIES

All inlets, outlets, valves, piping and other incidental work connected with installation of mechanical equipment supplied by other agencies all be carried out by the contractor in accordance with the drawings, requirements for proper performance of equipment, manufacturers instructions and the directions of the Owner's site representative / Architect. The equipments to be supplied by the other agencies consist mainly for Kitchen, Back-of-the-House area and other similar areas. The work of connections to the various equipments shall be effected through proper unions and isolating valves. The work of effecting connections shall be executed in consultation with and according to the requirement of equipment suppliers, under the directions of the Owner's site representative / Architect. The various aspects of connection work shall be executed in a similar way to the work of respective trade mentioned elsewhere in these specifications.

13. CONNECTIONS TO RCC WATER TANKS

The contractor shall provide all inlets, outlets, washouts, vents, ball cocks, overflows control valves and all such other piping connections including level indicator to water storage tanks as called for. All pipes crossing through RCC work shall have puddle flanges fabricated from MS/GI pipes of required size and length and welded to 6/8 mm thick MS plate. All puddle flanges must be fixed in true alignment and level to ensure further connection in proper order.

Full way gate valves of a approved make shall be provided as near the tank as practicable on every outlet pipe from the storage tank except the overflow pipe. Overflow and vent pipes shall terminate with mosquito proof grating.

The overflow pipe shall be so placed to allow the discharge of water being readily seen. The overflow pipe shall be of size as indicated. A stop valve shall also be provided in the inlet water connection to the tank. The outlet pipes shall be fixed approximately 75mm above the bottom of the tank towards which the floor of the tank is sloping to enable the tank to be emptied for cleaning.

The floor and the walls of the tank shall be tiled with glazed tiles upto the overflow level. Alternatively food grade epoxy to be applied.

Tiling of Walls

The floor and the walls of the tanks shall be tiled with glazed tiles up to the overflow level. Alternatively food grade epoxy to be applied to the floor and the walls of the tanks.

14. MEASUREMENTS

The length above ground shall be measured in running meter correct to a cm for the finished work, which shall include pipe and fittings such as coupling , bends, tees, elbows, reducers, crosses, plugs, sockets, nipples and nuts, unions. Deductions for length of valves shall be made. Rate quoted shall be inclusive of all fittings, clamps, cutting holes chased and making good the same and all items mentioned in the specifications and Bill of Quantities.

All pipes below ground shall be measured per linear meters (to the nearest cm) and shall be inclusive of all fittings e.g. coupling, tees, bends, elbows, unions, deduction for valves shall be made rate quoted shall be inclusive of all fittings, excavation, back filling and disposal of surplus earth, cutting holes and chase and making good all item mentioned in Bill of Quantities.

15. LAWN HYDRANTS

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

16. PIPE PROTECTION (FOR COLD WATER PIPES BURIED IN TRENCHES / GROUND / EARTH)

All buried pipes shall be cleaned with zinc chromate primer and bitumen paint, wrapped with three layers of fiber glass tissue, each layer laid in bitumen and placed on concrete blocks with PUF saddles dipped in bitumen at every 2 meters. The pipes where laid under floor shall be encased with 100 mm thick jamuna sand all around in addition to protective coating as described above. Alternatively pypcoat / coatek insulation for protection of pipe would also be acceptable as per final approval of project engineer / consultant.

17. THRUST BLOCKS

In case of bigger pipes (80 mm dia and above), thrust blocks of cement concrete 1:2:4 (1 cement: 2 coarse sand : 4 graded stone aggregate of 20 mm nominal size) shall be constructed on all bends as directed by the Owner's site representative.

18. MASONRY CHAMBER

i. All masonry chambers for stop cocks, sluice valves and meter etc. shall be built as per supplied drawings.

ii. The excavation for chambers shall be done true to dimension and level indicated on plans or as directed by the Owner's site representative.

iii. Concrete shall be of cement concrete 1:3:6 (1 cement : 3 coarse sand : 6 graded stone aggregate 40 mm nominal size.

iv. Brick shall be of class designation 75 in cement mortar 1:5 (1 cement : 5 fine sand)

v. Inside Plastering not less than 12 mm thick shall be done in cement mortar 1:3 (1 cement : 3 fine sand) finished with a floating coat of neat cement.

19. SHIFTING OF EXCAVATED SURPLUS MATERIAL

Contractor shall make his own arrangement to shift the surplus excavated material within the site limits as directed by Owner's site representative at free of cost within time limit.

20. HOT WATER PIPING INSULATION

MATERIAL

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

Thickness of the insulation shall be as specified for the individual application. Each lot of insulation material delivered at site shall be accompanied with manufacturer test certificate for thermal conductivity values. Samples of insulation material from each lot delivered at site may be selected by Owner's site representative and gotten tested for
Thermal conductivity and density at Contractor's cost all joints shall be sealed properly with adhesive, which shall provide similar vapour barrier as the original insulating material.

All hot water piping shall be insulated in the manner specified herein. Before applying insulation, all pipes shall be brushed and cleaned. Thermal insulation shall be applied as follows or as specified in drawings or schedule of quantity:

Pipe size (mm)	Thickness of Nitrile Rubber Insulation
15 mm to 25 mm	9 mm
32 mm to 50 mm	13 mm
65 mm and above	19 mm

Insulation for pipes in wall chase and for pipes in shaft / plant room.

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

Wherever flat sheets shall be used it shall be cut out in correct dimension. All longitudinal and transverse joints shall be sealed as per manufacturer recommendations. The insulation shall be continuous over the entire run of piping, fittings and valves. All valves, fittings, joints, strainers etc. in

hot water piping shall be insulated to the same thickness as specified for the main run of piping and application shall be same as above. Valves bonnet, yokes and spindles shall be insulated in such a manner as not to cause damage to insulation when the valve is used or serviced.

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

Protective Coating Over Insulation

To provide mechanical strength and protection from damage all exposed pipe insulated with nitrile rubber as indicated in BOQ shall be covered with fibreglass fabric. The fibreglass fabric shall be applied with one coat of fire proof epoxy or acrylic compound (resin & hardner). The coat shall be allowed to cure to non stick state. Subsequently second coat of compound shall be applied to give a tough and smooth finish to the insulated surface.

Measurement of Insulation

Unless otherwise specified measurement for pipe insulation for the project shall be on the basis of centre line measurements described herewith

Pipe Insulation shall be measured in units of length along the centre line of the installed pipe, strictly on the same basis as the piping measurements. The linear measurements shall be taken before the application of the insulation. It may be noted that for piping measurement, all valves, orifice plates and strainers shall not be separately measurable by their number and size. It is to be clearly understood that for the insulation measurements, all these accessories including valves, orifice plates and strainers etc. shall be considered strictly by linear measurements along the centre line of pipes and no special rate shall be applicable for insulation of any accessories, fixtures or fittings whatsoever.

SECTION - 04 :: INTERNAL DRAINAGE (SOIL, WASTE, VENT & RAIN WATER PIPES)

1. SCOPE

The scope of this section comprises the supply, installation, testing and commissioning of internal drainage services.

Work under this section shall consist of furnishing all labour, materials, equipments and appliances necessary and required to completely install all soil, waste, vent and rainwater pipes and fittings as required by the drawings, and given in the schedule of quantities.

2. BASIC PIPING SYSTEM

Soil, waste and vent pipes in shafts, ducts and in concealed areas i.e. false ceilings etc. shall consist of cast iron pipes & fittings as called for. In general wastes and vents smaller than and upto 50mm dia shall be of heavy class GI.

The soil pipes shall be circular with a minimum diameter of 100mm. Pipes shall be fixed by means of stout GI clamps in two sections, bolted together, built into the walls, wedged and neatly jointed as directed and approved by the Owner's site representative / Architect. All bends, branches, swan neck and other parts shall conform to the requirement and standards as described for the pipes. Pipes shall be rested against the walls on suitable wooden cradles. Local authority regulations applicable to the installations shall be strictly followed.

Where indicated, the soil pipes shall be continued upwards without any diminution in its diameter, without any bend or angle to the height shown in the drawings. Joints throughout shall be made with molten lead as described under jointing of cast iron pipes. Soil pipes shall be painted as provided under `painting'. The soil pipes shall be covered on top with cast iron terminal outlets as directed and approved. All vertical soil pipes shall be firmly fixed to the walls with properly fixed clamps, and shall as far as possible be kept 50mm clear of wall. Waste pipes and fittings shall be of cast iron or galvanised mild steel pipes. Pipes shall be fixed, jointed and painted as described in installation of soil, waste & vent pipes.

Every waste pipe shall discharge above the grating of properly trapped gully. The contractor will ensure that this requirement is adequately met with. Wherever floor traps are provided, it shall be ensured that atleast one wash is connected to such floor traps to avoid drying of water seal in the trap. Ventilating pipes shall be of cast iron or galvanised mild steel pipes, conforming to the requirements laid down earlier. Anti-syphon vent pipes/relief vent pipes where called for on the drawings shall be of cast iron or galvanised mild steel pipes as specified. The pipes shall be of the diameter shown on the drawings.

All traps on branch soil and waste pipes shall also be ventilated at a point not less than 75mm or more than 300mm from their highest part and on the side nearest to the soil pipe or waste pipes.

Access doors for fittings and clean outs shall be so located that they are easily accessible for repair and maintenance. Any access panel required in the civil structure, false ceiling or marble cladding etc. shall be clearly reported to the Owner in the form of shop drawings so that other agencies are instructed to provide the same.

All the fittings used for connections between soil, waste and ventilation pipes and branch pipes shall be made by using pipe fittings with inspection doors for cleaning. The doors shall be provided with 3mm thick rubber insertion packing and when closed and bolted shall be air and water tight.

Where soil, waste and ventilating pipes are accommodated in shafts ducts, adequate access to cleaning eyes shall be provided.

Head (starting point) of drains and sewage / waste water sumps (as and where applicable) having a length of greater than 4 m upto it connection to the main drain or manhole shall be provided with a 80 / 100 mm vent pipe.

3. PIPING MATERIALS

3.1 Cast Iron Pipes

Cast iron pipes and fittings shall be of good and tough quality and dark grey on fracture. The pipes and fittings shall be true to shape, smooth and cylindrical, their inner and outer surface being as nearly as practicable concentric. They shall be sound and nicely cast, shall be free from cracks, taps, pinholes and other manufacturing defects.

The pipes and fittings shall conform to IS: 3989 / IS: 1729 as called for. Fittings shall be of required degree with or without access door. All access doors shall be made up with 3mm thick insertion rubber gasket of white lead and tightly bolted to make the fittings air and water tight. The fittings shall be of the same manufacture as the pipes used for soil and waste.

All CI pipes and fittings shall bear the manufacturer's name and ISI specification to which it conforms.

All pipes and fittings shall be coated internally and externally with the same material at the factory, the fittings being preheated prior to total immersion in a bath containing a uniformly heated composition having a tar/other suitable base. The coating material shall have good adherence and shall not scale off. The coating shall be smooth and tenacious and hard enough not to flow when exposed to a temperature

of 77 degree C but not so brittle at a temperature of '0' degree C as to chip off when scratched lightly with a pen knife.

All pipes and fittings before installation at site shall be tested hydrostatically to a pressure of 0.45 Kg/sq. cm without showing any sign of leakage, sweating or other defects of any kind. The pressure shall be applied internally and shall be maintained for not less than 15 minutes. All these tests shall be carried out in the presence of the representative of the Project Manager. Alternatively a test certificate from manufacturers be obtained before dispatch of material to site.

Cast Iron Specialities

If required, Cast iron speciality items such as deep seal floor traps, urinal traps, trap integral pieces with integral inlet/outlet connections, manhole cover with frame, chamber cover etc. shall be fabricated to suit individual location requirements. The contractor shall arrange the fabrication of these items from an approved source.

Lead Caulked joints with pig lead:

The approximate depth and weights of pig lead for various diameters of CI pipes and specials shall be as follows:

Nominal size of Pipe (mm)	Lead per Joint (Kg)	Depth of Lead Joint (mm)
50	0.77	25
80	0.88	25
100	0.99	25
150	1.5	38

Drip Seal Joints :

Drip seal PJS-43 (pipe joint sealant) shall be used for joining various diameters of C.I. pipes and specials. This sealant replaces the standard Drip seal caulked joints. The application is by homogenously mixing the two pack system in cold condition. Drip seal PJS - 43 is the proprietary item of M/s. Vinod Cement Co., Chandigarh.

Application Procedure:

Clean the pipe joints thoroughly to ensure it is free from any traces of oil, dirt or any other foreign body. Mix two parts of Drip Seal thoroughly with an iron flat to get a homogenous compound. ***** Place Spun yarn in the pipe joint as a filler and then take the required quantity of the compound and push it in the joint with a caulking tool, MS flat / damp finger uniformly all over to obtain a smooth and uniform joint. Dip the fingers in water every often to ensure the compound does not stick to the hands of the workmen, but this will ensure perfect sealing and the smooth surface for the joint cement. (***** The compound prepared from the two mixtures is to be used within 30 minutes) Precaution to be taken to wash hands thoroughly with soap before and after use. Preferably use disposable gloves for hand application.

3.2 Galvanised Iron Pipes

Waste pipes of 50mm dia and below and where called for shall be galvanised iron pipes screwed and socketed conforming to the requirements of IS:1239 of heavy grade. The pipes and sockets shall be cleanly finished, well galvanised in and out and free from cracks, surface flaws, laminations and other defects. All screw thread shall be clean and well cut. All pipes and fittings shall bear manufacturer's trade mark and conform to the IS as specified.

3.3 UPVC Pipes and Fittings

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, and free from groovings and other defects. The ends shall be cleanly cut and square with the axis of the pipe. The pipes shall be designed by external diameter and shall conform to IS: 4985-1981. The pipes shall be of Class-III; 6 Kg/sqm pressure rating.

Fittings

Fittings shall be of the same make as that of pipes, injection moulded and shall conform to Indian Standard.

Laying and Jointing

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. Provision shall be made for the effect of thermal movement by not gripping or disturbing the pipe at supports between the anchors for suspended pipes. The supports shall allow the repeated movements to take place without abrasion.

Jointing for UPVC pipes shall be made by means of solvent cement for horizontal lines and 'O' rubber ring for vertical line. The type of joint shall be used as per site conditions / direction of the Owner's site representative. Where UPVC pipes are to be used for rain water pipes, the pipe shall be finished with GI adopter for insertion in the RCC slab for a water proof joint complete as directed by Owner's site representative.

Supports

UPVC pipes require supports at close intervals. Recommended support spacing for unplasticised PVC pipes is 1400 mm for pipes 50 mm dia and above. Pipes shall be aligned properly before fixing them on the wooden plugs with clamps. Even if the wooden plugs are fixed using a plumb line, pipe shall also be checked for its alignment before clamping, piping shall be properly supported on, or suspended from clamps, hangers as specified and as required. The Contractor shall adequately design all the brackets, saddles, anchors, clamps and hangers and be responsible for their structural sufficiency. Pipe supports shall be primer coated with rust preventive paint.

Repairs

While temporary or emergency repairs may be made to the damaged pipes, permanent repairs shall be made by replacement of the damaged section. If any split or chip out occur in the wall of the pipe, a short piece of pipe of sufficient length to cover the damaged portion of the pipe is cut. The sleeve is cut longitudinally and heated sufficiently to soften it so that it may be slipped over the damaged hard pipe.

3.4 Cast Iron Class (LA) pipes

All drainage passing under building floor and passing through retaining wall shall be cast iron class (LA) pipes (IS : 1536)

Cast iron class (LA) pipe shall be such that they could be cut, drilled or machined. Pipe centrifugally cast in unlined water cooled moulds shall be heat treated in order to achieve the necessary mechanical properties and to relieve casing stress; provided that the specified mechanical properties are satisfied.

Material

Cast iron pipe shall be centrifugally spun cast iron pipe and conforming to IS:1536-1976

Fittings

Fittings shall be used for cast iron class (LA pipes shall conform to IS:1538-1976). Whenever possible junction from branch pipe shall be made by wyes.

All cast iron water main pipes and fittings shall be manufactured to IS:1536 of tested quality. The pipes and fittings shall either be spigot and socket type or as called for. The pipes and fittings shall be of uniform material throughout and shall be free from all manufacturing defects.

Joints

Cast iron class (LA) pipe used for soil and waste pipes shall be jointed with **drip seal** / lead joints sufficient skein of jute rope shall be caulked to leave minimum space of 25 mm for the **drip seal**. Lead to be poured in.

Laying

Fittings used for CI drainage pipe shall conform to IS:1538-1976. Wherever possible junction from branch pipes shall be made by a Y/tee.

Drip Seal Joints :

Drip seal PJS-43 (pipe joint sealant) shall be used for joining various diameters of C.I. pipes and specials. This sealant replaces the standard Drip seal caulked joints. The application is by homogenously mixing the two pack system in cold condition. Drip seal PJS - 43 is the proprietary item of M/s. Vinod Cement Co., Chandigarh.

Application Procedure:

Clean the pipe joints thoroughly to ensure it is free from any traces of oil, dirt or any other foreign body. Mix two parts of Drip Seal thoroughly with an iron flat to get a homogenous compound. ***** Place Spun yarn in the pipe joint as a filler and then take the required quantity of the compound and push it in the joint with a caulking tool, MS flat / damp finger uniformly all over to obtain a smooth and uniform joint. Dip the fingers in water every often to ensure the compound does not stick to the hands of the workmen, but this will ensure perfect sealing and the smooth surface for the joint cement. (***** The compound prepared from the two mixtures is to be used within 30 minutes) Precaution to be taken to wash hands thoroughly with soap before and after use. Preferably use disposable gloves for hand application.

ii. Lead Caulked joints with pig lead :

The approximate depth and weights of pig lead for various diameters of CI pipes and specials shall be as follows:

Nominal size of Pipe (mm)	Lead per Joint (Kg)	Depth of Lead Joint (mm)
80	1.8	45
100	2.2	45
125	2.6	45
150	3.4	50
200	5.0	50

250	6.1	50

iii. The spigot of pipe of fittings shall be centered in the adjoining socket by caulking. Sufficient turns of tarred gasket shall be given to leave a depth of 45 mm when the gasket has been caulked tightly home. Joining ring shall be placed round the barrel and against the face of the socket. Molten Lead shall then be poured to the remainder of the socket.

iv. For lead wool joints the socket shall be caulked with tarred gasket, as explained above. The lead wool shall be inserted into the sockets and tightly caulked home skin by skin with suitable tools and hammers of not less than 2 Kg weight until joint is filled.

4. PIPES HANGERS, SUPPORTS, CLAMPS ETC.

All vertical pipes shall be fixed by galvanized clamps and galvanized angle brackets 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).

Horizontal pipes running along ceiling shall be fixed on galvanized structural adjustable clamps of special design shown on the drawings or as directed. Horizontal pipes shall be laid to uniform slope and the clamps adjusted to the proper levels so that the pipes fully reset on them.

Contractor shall provide all sleeves, openings, hangers, inserts during the construction. He shall provide all necessary information to the building contractor for making such provisions in the structure as necessary. All damages shall be made good to restore the surfaces.

All pipes clamps, supports and hangers shall be galvanized. Factory made prefabricated clamps shall be preferred. Contractor may fabricate the clamps of special nature and galvanize them after fabrication but before installation. All nuts, bolts, washers and other fasteners shall be factory galvanized.

Clamps shall be of approved design and fabricated from MS flats (which shall be galvanized after fabrication) of thickness and sizes as per drawings or contractor's shop drawings. Clamps shall be fixed in accordance to manufacturer's details/shop drawings to be submitted by the contractors.

When required to be fixed on RCC columns, walls or beam they shall be fixed with approved type of galvanized expansion anchor fasteners (Dash fasteners) of approved design and size according to load.

Structural clamps e.g.. trapeze or cluster hangers shall be fabricated by electro-welding from MS structural members e.g. rods, angles, channels flats as per contractors shop drawings shall be galvanized after fabrication. All nuts, bolts and washers shall be galvanized.

Galvanized slotted angle/channel of approved sizes supports on walls shall be provided wherever shown on shop drawings. Angles/channels shall be fixed to brick walls with bolts embedded in cement concrete blocks and to RCC walls with anchor fasteners mentioned above. The spacing of support bolts on support members fixed horizontally shall not exceed 1 m.

5. INSTALLATION OF SOIL, WASTE & VENT PIPES

Soil, waste & vent pipes in shafts under the floors / suspended below slab shall consist of cast iron pipes as described earlier. Waste pipes from bottle trap to floor/urinal traps for wash basin, urinal and sink shall be GI pipes and fittings.

All Horizontal pipes running below the slab and along the ceiling, shall be fixed on structural adjustable clamps, sturdy hangers of the design as called for in the drawings. The pipes shall be laid in uniform slope and proper levels. All vertical pipes shall be truly vertical fixed by means of stout clamps in two sections,

bolted together, built into the walls, wedged and neatly jointed. The branch pipes shall be connected to the stack at the same angle as that of fittings. All connections between soil, waste and ventilating pipes and branch pipes shall be made by using pipe fittings with inspection doors for cleaning. Pipes shall be fixed in a manner as to provide easy accessibility for repair and maintenance and shall not cause obstruction in shafts. Where the horizontal run off the pipe is long or where the pipes cross over building expansion joints etc. suitable allowance shall be provided for any movements in the pipes by means of expansion joint etc. such that any such movement does not damage the installation in any way.

All cast iron pipes and fittings shall be jointed with drip seal / Best Quality pig lead free from impurities confirming to IS 27.

Before jointing, the interior of the socket and exterior of the spigots shall be thoroughly cleaned and dried. The spigot end shall be inserted into the socket right up to the back of the socket and carefully centered by two or three laps of threaded spun yarn, twisted into ropes of uniform thickness, well caulked into the back of the socket. No piece of yarn shall be shorter than the circumference of the pipe. The jointed pipe line shall be at required levels and alignment. The reminder of the socket is left for the lead caulking. Where the gasket has been tightly held, a jointing ring shall be placed round the barrel against the face of the socket. Molten Lead shall be poured to the remainder of the socket.

The depth of the lead joints for the cast iron pipes shall be 45mm for the pipes upto 100mm dia and 50mm for the pipes beyond 100mm dia respectively.

The joint shall not be covered till the pipe line has been tested under pressure. Rest of pipe line shall be covered so as to prevent the expansion and contraction due to variation in temperature.

Rainwater Pipes

All open terraces shall be drained by rain water down takes.

Rainwater down takes are separate and independent of the soil and waste system and will discharge into the underground storm water drainage system of the complex.

Rainwater in open courtyards shall be collected in catch basins and connected to the Storm Water Drains.

Any dry weather flow from waste appliances, e.g. AHU's pump rooms, waste water sumps shall connected to sewers after traps and not in the storm water drainage systems.

Balcony / Planter drainage

Wherever required, all balconies, terraces, planters and other frontal landscape areas will be drained by vertical down takes or other type of drainage system shown on the drawings and directed by the Project Manager.

6. TRAPS

6.1 Floor Traps

Floor traps where specified shall be siphon type full before P or S type cast iron having a minimum 50 mm deep seal. The trap and waste pipes when buried below ground shall be set and encased in cement concrete blocks firmly supported on firm ground or when installed on a sunken RCC structural slab. The blocks shall be in 1:2:4 mix (1 cement : 2 coarse sand : 4 stone aggregate 20 mm nominal size).

Contractor shall provide all necessary shuttering and centering for the blocks. Size of the block shall be 30 x 30 cms of the required depth.

6.2 Floor Trap Inlet /Hopper

Bath room traps and connection shall ensure free and silent flow of discharging water. Where specified, contractor shall provide a special type of floor inlet fitting fabricated from GI pipe, with one, two or three inlet sockets welded on side to connect the waste pipe. All joint between waste hopper and CI inlet socket shall be drip seal/Lead Caulked. Inlet shall be connected to a CI "P" trap. Floor trap inlet and the traps shall be set in cement concrete blocks where burried in floors without extra charge. Floor trap for the shower cubicle shall suit site and as per the approval of Owner's site representative. All fabricated hopper shall be hot dip galvanized.

6.3 Floor Trap Grating

Floor and urinal traps shall be provided with 100 – 150 mm square or round stainless steel gratings, with frame and rim of approved design and shape or as specified in the schedule of quantities approved by the Owner's site representative.

6.4 Cleanout Plugs

Floor Clean Out Plug

Clean out plug for soil, waste or rain water pipes laid under floors shall be provided near pipe junctions bends, tees, "Y" and on straight runs at such intervals as required as per site conditions. Cleanout plugs shall terminate flush with the floor level. They shall be threaded and provided with key holes for opening. Cleanout plugs shall be cast brass suitable for the pipe dia. With screwed to a GI socket. The socket shall be drip seal joined/ Lead Caulked to the drain pipes.

Cleanout on Drainage Pipes

Cleanout plugs shall be provided on head of each drain and in between at locations indicated on plans or directed by Owner's site representative. Cleanout plugs shall be of size matching the full bore of the pipe but no exceeding 150 mm dia CO plugs on drains of greater diameters shall be 150 mm dia. Fixed with a suitable reducing adapter.

Floor cleanout plugs shall be cast brass.

Cleanouts provided at ceiling level pipe shall be fixed to a CI flanged tail piece. The cleanout doors shall be specially fabricated from light weight galvanized sheets and angles with hinged type doors with fly nuts, gasket etc. as per drawing.

7. PIPE SLEEVES

Pipe sleeves, next larger diameter than pipes shall be provided wherever pipes pass through walls & slabs and annular space filled with fiberglass & finished with retainer rings. All pipes shall be accurately cut to the required sizes in accordance with relevant BIS codes and burrs removed before laying. Open ends of the pipe shall be closed as the pipe is installed to avoid entrance of foreign matter.

8. PIPE PROTECTION

Cast iron 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 of 12 mm size) 10 cm bed and around. When pipes are running well above the structural slabs, the encased pipes shall be supported with suitable cement concrete pillars of required height and size at intervals directed by the Project Manager.

9. CUTTING AND MAKING GOOD

Pipes shall be fixed and tested as building proceeds. The contractor shall provide all necessary holes, cutouts 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 cement mortar 1:2 (1 cement : 2 coarse sand). Cured and the surface restored to original condition.

10. PAINTING

Soil, waste, vent and rain water pipes in exposed location, in shafts and pipe space shall be painted with two or more coats of ready mix oil paint to give an even shade. Before painting all dust and extraneous matter shall be removed.

Paint shall be of approved quality and shade. Where directed by the Owner's site representative pipes shall be painted in accordance with approved pipe colour code.

Pipe in chase shall be painted with two coats of bitumen paint, covered with polythene tape and a final coat of bitumen paint. Exposed pipes shall be painted with synthetic enamel paint after removing dust and extraneous matter.

C.I. Soil and waste pipes below ground and covered in cement concrete shall not be painted.

11. TESTING

Testing shall be done in accordance with IS:1172 and IS:5329 except as may be modified herein under.

Entire drainage system shall be tested for water tightness and smoke 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 tests,

All materials obtained and used on site must have manufacturer's hydraulic test certificate for each batch of materials used on the site.

Before use at site all CI pipes shall be tested by filling up with water for at least 30 minutes. After filling, pipes shall be struck with a hammer and inspected for blow holes and cracks. All defective pipes shall be rejected and removed from the site within 48 hours. Pipes with minor sweating may be accepted at the discretion of the Project Manager.

Soil and waste pipes shall be tested in sections after installation, by filling up the stack with water. All openings and connections shall be suitably plugged as approved by the Project Manager. The total head in the stack shall be 4.5 m at the highest point of the section under test. The period of test shall be minimum for 30 minutes or as directed by the Project Manager. If any leakage is visible, the defective part of the work shall be cut out and made good.

On completion of the work the entire installation shall be tested by smoke testing machine. The test shall be conducted after the plumbing fixtures are installed and all traps have water seal or by plugging the outlets with bellow plugs. Apply dense smoke keeping the top of stack open and observe for leakages. Rectify or replace defective sections.

After the installation is fully complete, it should be tested by flushing the toilets, running atleast 20% of all taps simultaneously and ensuring that the entire system is self draining, has no leakages, blockages etc. rectify and replace where required.

A test register shall be maintained and all entries shall be signed and dated by the Contractor and the Project Manager or his representative.

All pipes in wall chase or meant to be encased or burried shall be hydro tested before the chase in plastered or the pipe encased or burried.

SECTION – 05 :: EXTERNAL DRAINAGE (SEWAGE & STORM WATER DISPOSAL)

1. SCOPE

The scope of this section comprises the supply, installation, testing and commissioning of external drainage & sewage disposal services.

1.1 General Scheme

The contractor shall install a drainage system to effectively collect, drain and dispose all soil and waste water from various parts of the buildings, appurtenances and equipment. The piping system shall finally terminate and discharge into the STP. The piping work mainly consists of laying of Salt glazed stoneware pipes, reinforced cement concrete pipes and cast iron soil pipes as called for on the drawings. All piping shall be installed at depth greater than 80 cm below finished ground level. The disposal system shall include construction of gully traps, manholes, intercepting chambers as indicated. The piping system shall be vented suitably at the starting point of all branch drains, main drains, the highest/lowest point of drain and at intervals as shown. All ventilating arrangements shall be unobstructive and concealed. The work shall be executed strictly in accordance with IS: 1742. The sewage system shall be subject to smoke test for its soundness as directed by the Project Manager. Wherever the sewerage pipes run above water supply lines, same shall be completely encased in cement concrete 1:2:4 all round with the prior approval of the Project Manager.

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

a. Sewer lines including earth work for excavation, disposal, back filling and compaction, pipe lines, manholes, drop connections and connections to the municipal or existing sewer.

b. Storm water drainage, earth works for excavation, disposal, backfilling and compaction, pipe lines, manholes, catch basins and connections to the existing municipal storm water drain or connected as indicated by the Project Manager.

General Requirements

All materials shall be new and of quality conforming to specifications and subject to the approval of the Owner's site representative. Wherever particular makes are mentioned, the choice of selection shall remain with the Architect / Consultant / Owner's site representative.

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

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

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

Location of all manholes, etc shall be got confirmed by the Project Manager before the actual execution of work at site. As far as possible, no drains or sewers shall be laid in the middle of

road unless otherwise specifically shown on the drawings or directed by the Project Manager in writing.

All materials shall be rust proofed; materials in direct or indirect contact shall be compatible to prevent electrolytic or chemical (bimetallic) corrosion.

2. TRENCHING FOR PIPES AND DRAINS

2.1 General

All the material shall be new of best quality conforming to specifications and subject to the approval of the Architects. Drainage lines shall be laid to the required gradients and profiles. All drainage work shall be done in accordance with the local municipal by-laws.

Contractor shall obtain necessary approval and permission for the drainage system from the municipal or any other competent authority. Location of all manholes, catch basins etc. shall be finalized and shown in approved shop drawings before the actual execution of work at site. All work shall be executed as directed by the Project Manager.

2.2 Alignment & Grade

The sewer and storm water drainage pipes shall be carefully laid to levels and gradients shown in the plans and sections but subject to modifications as shall be ordered by the Architects from time to time to meet the requirements of the works. Great care shall be taken to prevent sand etc. from entering the pipes. The pipes between two manholes shall be laid truly in straight lines without vertical or horizontal undulations. The body of the pipes shall rest on an even bed in the trench for its length and places shall be excavated to receive collar for the purpose of jointing. No deviations from the lines, depths of cuttings or gradients as called for on the drawings shall be permitted without the written approval of the Architect. All pipes shall be laid at least 60cms below the finished ground level or as called for on the drawings.

2.3 Setting out Trenches

The contractor shall set out all trenches, manholes, chambers and such other works to true grades and alignments as called for. He shall provide the necessary instruments for setting out and verification for the same. All trenches shall be laid to true grade and in straight lines and as shown on the drawings. The trenches shall be laid to proper levels by the assistance of boning rods and sight rails which shall be fixed at intervals not exceeding 10 meters or as directed by the Project Manager.

2.4 Trench Excavation

The trenches for the pipes shall be excavated with bottoms formed to level and gradients as shown on the drawings or as directed by the Project Manager. In soft and filled in ground, the Project Manager may require the trenches to be excavated to a greater depth than the shown on the drawings and to fill up such additional excavation with concrete (1:4:8) consolidated to bring the excavation to the required levels as shown on the drawings.

All excavations shall be properly protected where necessary by suitable timbering, piling and sheeting as approved by the Project Manager. All timbering and sheeting when withdrawn shall be done gradually to avoid falls. All cavities be adequately filled and consolidated. No blasting shall be allowed without prior approval in writing from the Architect. It shall be carried out under thorough and competent supervision, with the written permission of the appropriate authorities taking full precautions connected with the blasting operations. All excavated earth shall be kept clear of the trenches to a distance equal to 75 cms.

2.5 **Timbering of Sewer and Trenches**

The Contractor shall at all times support efficiently and effectively the sides of all the trenches and other excavations by suitable timbering, piling and sheeting and they shall be close timbered in loose or sandy starta and below the surface of the sub soil water level.

All timbering, sheeting and piling with their wallings and supports shall be of adequate dimensions and strength and fully braced and strutted so that no risk of collapse or subsidence of the walls of the trench shall take place.

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

2.6 **Shoring of Buildings**

The Contractor shall shore up all buildings, walls and other structures, the stability of which is liable to be endangered by the execution of the work and shall be fully responsible for all damages to persons or property resulting from any accident.

2.7 **Obstruction Road**

The contractor shall not occupy or obstruct by his operation more than one half of the width of any road or street and sufficient space shall then be left for public and private transit. He shall remove the materials excavated and bring them back again when the trench is required to be refilled. The contractor shall obtain the consent of the Project Manager in writing before closing any road to vehicular traffic and the foot walks must be clear at all times.

2.8 **Protection of Pipes etc**

All pipes, water mains, cables etc. met in the course of excavation shall be carefully protected and supported. Care shall be taken not to disturb the cables, the removal of which shall be arranged by the contractor with the written consent from the Project Manager.

2.9 **Trench Back Filling**

Refilling of the trenches shall not be commenced until the length of pipes therein has been tested and approved. All timbering which may be withdrawn safely shall be removed as filling proceeds. Where the pipes are unprotected by concrete hunching, selected fine material shall be carefully hand-packed around the lower half of the pipes so as to buttress them to the sides of the trench.

The refilling shall then be continued to 150mm over the top of the pipe using selected fine hand packed material, watered and rammed on both sides of the pipes with a wooden hammer. The process of filling and tamping shall proceed evenly in layers not exceeding 150mm thickness, each layer being watered and consolidated so as to maintain an equal pressure on both sides of the pipe line. In gardens and fields the top solid and turf if any, shall be carefully replaced.

2.10 **Contractor to restore settlement and Damages**

The contractor shall at his own costs and expenses, make good promptly during the whole period for the works in hand if any settlement occurs in the surfaces of roads, beams, footpaths, gardens, open spaces etc. in the public or private areas caused by his trenches or by his other excavations and he shall be liable for any accident caused thereby. He shall also, at his own expense and charges, repair (and make good) any damage done to building and other property. If in the opinion

of the Project Manager he fails to make good such works with all practicable dispatch, the Project Manager shall be at his liberty to get the work done by other means and the expenses thereof shall be paid by the contractor or deducted from any money that may be or become due to him or recovered from him by any other manner according to the laws of land.

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

2.11 **Removal of Water from Sewer, Trench etc.**

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

If any excavation is carried out at any point or points to a greater width of the specified cross section of the sewer with its cover, the full width of the trench shall be filled with concrete by the contractor at his own expense and charges to the requirements of the Project Manager.

2.12 **Removal of Filth**

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

2.13 **Width of Trench**

The Project Manager shall have power by giving an order in writing to the Contractor to increase the maximum width/depth for excavation and backfilling in trenches for various classes of sewer, manholes and other works in certain length to be specifically laid down by him, where on account of bad ground on other unusual conditions, he considers that such increased width/depths are necessary in view of the site conditions.

3. PIPING MATERIAL

3.1 **RCC pipes**

All pipes shall be centrifugally spun RCC pipes NP2. Pipes shall be true and straight with uniform bore throughout. Cracked, warped pipes shall not be used on the work. All pipes shall be tested by the manufacturer and the Contractor shall produce, prior to use on site, a certificate to that effect from the manufacturer.

The pipes shall be with or without reinforcement as required and of the class as specified. These shall conform to IS:458-1971.

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.

Laying

RCC spun pipes shall be laid on cement concrete bed of cradles as specified and shown on the detailed drawings. The cradles may be precast and sufficiently cured to prevent cracks and breakage in handling. The invert of the cradles shall be left 12 mm below the invert level of the pipe and properly placed on the soil to prevent any disturbance. The pipe shall then be placed on `the bed concrete or cradles and set for the line and gradient by means of sight rails and boning rods, etc. Cradles or concrete bed may be omitted, if directed by the Project Manager.

Jointing

Semi flexible type collar joint.

Hemp rope soaked in neat cement wash shall be passed round the joint and inserted in it by means of caulking tool. More skein of yarn shall be added and rammed home. Cement mortar with one part of cement and two part of sand and with minimum water content but on no account soft or sloppy, shall be carefully inserted, punched and caulked into the collar and more cement mortar added until the space of the collar has been filled completely with tightly caulked mortar. Provision of rubber sealing ring in the collar joint shall also be made. The joint shall then be finished off neatly outside the socket at an angle of 45 deg.

Curing:

The joint shall be cured for at least seven days. Refilling at joints will be permitted only on satisfactory completion of curing period.

Cement Concrete for Pipe Supports:

a. Unless otherwise directed by the Project Manager cement concrete for bed, all round or in haunches shall be as follows:

	upto 1.5 m depth	**upto 3 m depth**	**beyond 3 m depth**
Stoneware pipes buried in open ground (No sub soil water)	All round (1:3:6)	In Haunches (1:3:6)	In Haunches (1:3:6)
RCC or SW in sub soil water	All round (1:3:6)	In Haunches (1:3:6)	In Haunches (1:3:6)
PVC / HDPE pipe	All round (1:2:4)	In Haunches (1:3:6)	In Haunches (1:3:6)
CI Pipes (in all conditions)	All round (1:4:8)	In Haunches (1:4:8)	In Haunches (1:4:8)
All pipes under building	All round (1:2:4)	All round (1:2:4)	All round (1:2:4)

b. b. Pipes may be supported on brick masonry or precast RCC or in situ cradles. Cradles shall be as shown on the drawings.

c. c. Pipes in loose soil or above ground shall be supported on brick or stone masonry pillars as shown on the drawings.

Measurement:

a. Excavation : Measurement for excavation of pipes trenches shall be made per linear meter.

b. Trenches shall be measurement between outside walls of manholes at top and the depth shall be the average depth between the two ends to the nearest cm. The rate quoted shall be for a depth upto 1.5 metre or as given in the Bill of Quantities.

c. Payment for trenches more than 1.5 m in depth shall be made for extra depth as given in the Bill of Quantities and above the rate for depth upto 1.5 m.

d. c. RCC pipes shall be measured for length of the pipe line per linear meter.

i. Length between manholes shall be recorded from inside of one manhole or inside of other manhole.

ii. Length between gully trap and manhole shall be recorded between socket of pipe near gully trap and inside of manhole.

3.2 **UPVC Pipes and Fittings**

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 designed by external diameter.

Fittings

Fittings shall be of the same make as that of pipes, injection moulded and shall conform to Indian Standard.

Laying in Trenches
UPVC pipes shall be laid on cement concrete bed of width 300mm over the outside diameter of pipe, and 100 mm thickness. Fine sand shall be carefully filled around the lower half of the pipes so as to buttress them to the sides of the trench.

The filling shall then be continued to 150mm over the top of the pipe using fine sand, watered and rammed on both sides of the pipes. The process of filling and ramming with fine hand picked material shall proceed evenly in layers not exceeding 150mm thickness, each layer being watered and consolidated so as to maintain an equal pressure on both sides of the pipe line.

3.3 **Cast Iron Class (LA) Pipe**

All drainage line passing under building, floors and roads with heavy traffic shall be Cast Iron Class (LA) Pipe.

Cast Iron Class (LA) pipe shall be such that they could be cut, drilled or machined. Pipe centrifugally cast in unlined water cooled moulds shall be heat treated in order to achieve the necessary mechanical properties and to relieve casting stresses; provide that the specified mechanical properties are satisfied.

Material

Cast iron pipe shall be centrifugally spun cast iron pipes and conforming to IS:1536-1976.

Fittings

Fittings shall be used for Cast Iron Class (LA) Pipes shall conform to IS:1538-1976. Whenever possible junction from branch pipe shall be made by Wyes.

Laying

Fittings used for C.I drainage pipe shall conform to IS:1538-1976. Whenever possible junction from branches pipes shall be made by a Wyes.

All cast iron pipes and fittings shall be jointed with best quality soft pig lead (conforming to IS 782-1966) which shall be free from impurities. In wet trenches joints shall be made from lead wool. Nothing extra will be paid for lead wool joints. Depth of pig lead and weight for joints shall be as given in table below:

Lead caulked Joints with Pig Lead

The approximate depth and weights of Pig Lead for various diameters of C I pipes and specials shall be as follows:

Nominal Size of Pipe mm	**Lead per joint Kg**	**Depth of Lead Joint mm**
80	1.8	45
100	2.2	45
125	2.6	45
150	3.4	50
200	5.0	50
250	6.1	50

The spigot of pipe of fittings shall be centred in the adjoining socket by caulking. Sufficient turns of tarred gasket shall be given to leave a depth of 45 mm when the gasket has been caulked tightly home. Joining ring shall be placed round the barrel and against the face of the socket. Molten pig lead shall then be poured to fill the remainder of the socket. This shall then be done in one pouring. The lead shall then be solidly caulked with suitable tools and hammers weighting not less than 2 Kgs.

Drip Seal Joints :

Drip seal PJS-43 (pipe joint sealant) shall be used for joining various diameters of C.I. pipes and specials. This sealant replaces the standard Drip seal caulked joints .The application is by Homogenously mixing the two pack system in cold condition. Drip seal PJS - 43 is the proprietary item of M/s. Vinod Cement Co., Chandigarh.

Application Procedure:

Clean the pipe joints thoroughly to ensure it is free from any traces of oil, dirt or any other foreign body. Mix two parts of Drip Seal thoroughly with an iron flat to get a homogenous compound. ***** Place Spun yarn in the pipe joint as a filler and then take the required quantity of the compound and push it in the joint with a caulking tool, MS flat / damp finger uniformly all over to obtain a

smooth and uniform joint. Dip the fingers in water every often to ensure the compound does not stick to the hands of the workmen, but this will ensure perfect sealing and the smooth surface for the joint cement. (***** The compound prepared from the two mixtures is to be used within 30 minutes) Precaution to be taken to wash hands thoroughly with soap before and after use. Preferably use disposable gloves for hand application.

Measurement:

a. Excavation: Measurement for excavation of pipes trenches shall be made per linear meter.

b. Trenches shall be measurement between outside walls of manholes at top and the depth shall be the average depth between the two ends to the nearest cm. The rate quoted shall be for a depth upto 1.5 metre or as given in the Bill of Quantities.

Payment for trenches more than 1.5 m in depth shall be made for extra depth as given in the Bill of Quantities and above the rate for depth upto 1.5 m.

c. C.I class (LA) pipes shall be measured for the length of the pipe line per linear meter i.e:

i. Length between manholes shall be recorded from inside of one manhole or inside of other manhole.

ii. Length between gully trap and manhole shall be recorded between socket of pipe near gully trap and inside of manhole.

3.4 Salt Glazed Stoneware Pipes

Stoneware pipes shall be new and of First Class quality salt glazed and free from rough texture inside and outside and straight. All pipes shall comply with IS:651 and have the manufacturers name marked on them.

Laying of Salt Glazed Stoneware Pipes:

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

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

Where pipes are not bedded on concrete the trench bottom shall be left slightly high and carefully bottomed up as pipes laying proceeds so that the pipe barrels rest on firm ground. If excavation has been carried to low it shall be made up with cement concrete 1:4:8 (1 cement : 4 coarse sand : 8 stone aggregate 20mm nominal size) at the Contractor's cost and charges

Jointing of Salt Glazed Stoneware Pipes:

Tarred gaskin shall first be wrapped round the spigot of each pipe and the spigot shall then be placed into the socket of the pipe previously laid, the pipe shall then be adjusted and fixed in its

correct position and the gaskin caulked tightly home so as to fill not more than one quarter of the total length of the socket.

The remainder of the socket shall be filled with stiff mix of cement mortar (1cement: 1 clear sharp washed sand). When the socket is filled, a fillet shall be of 45 degrees with the barrel of that pipe. The mortar shall be mixed as needed for immediate use and no mortar shall be beaten up and used after it has begun to set.

After the joint has been made any extraneous materials shall be removed from the inside of the joint with a suitable scarper of "badger". The newly made joints shall be protected until set, from the sun, drying winds, rain or dust. Sackling or other materials which can be kept damp shall be used. The joints shall be exposed and space left all around the pipes for inspection by the Project Manager. The inside of the sewer must be left absolutely clear in bore and free from cement mortar or other obstructions throughout its entire length, and shall efficiently drain and discharge.

S.W. Gully Trap

Gully trap shall be stoneware conforming to IS:651. These shall be sound and free from visible defects such as fire cracks, or hair cracks. The glaze of the traps shall be free from cracks. They shall give a sharp clear note when struck with light hammer. There shall be no broken blisters. Each gully trap shall have one CI grating of square size corresponding to the dimensions of inlet of gully trap. It will also have a water tight CI cover with frame inside dimensions 300 x 300mm the cover weighing not less than 4.5 kg and the frame not less than 2.7kg. The grating cover and frame shall be of good casting and shall have truly square machined seating faces.

Fixing of S.W. Gully Trap

The excavation for gully traps shall be done true to dimensions and levels as indicated on plans or as directed by the Project Manager /Consultant / Architect. The gully traps shall be fixed on cement concrete foundation 65cm square and not less than 10cm thick. The mix for the concrete will be 1:4:8. The jointing of gully outlet to the branch drain shall be done similar to the jointing of S.W. Pipes described earlier. After fixing and testing gully and branch drain, a brick work of specified class in cement mortar 1:5 shall be built with a half brick masonry work round the gully trap from the top of the bed concrete upto ground level. The space between the chamber and trap shall be filled in with cement concrete 1:3:6. The upper portion of the chamber i.e. above the top level of the trap shall be plastered inside the cement mortar 1:3 finish with a floating coat of neat cement. The corners and bottom of the chamber shall be rounded off so as to slope towards the grating.

CI cover with frame 300 x 300 mm (inside) shall then be fixed on the top of the brick masonry with cement concrete 1:2:4 and rendered smooth. The finished top cover shall be so as to prevent the surface water from entering the gully trap.

Measurements

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

3.5 High Density Polyethylene (HDPE) Pipes

3.5.1 Specifications

Wherever specified, High Density Polyethylene (HDPE) pipes for sewage and storm water disposal shall conform to IS : 14333-1996 (Material Grade PE-63) and be of appropriate pressure rating.

The pipes shall be reasonable round and shall be supplied in straight lengths with socketed or plain ends as specified. The internal and external surfaces of the pipes shall be smooth and clean, free from grooving and other defects.

Properties	**Specification**	**Unit**	
Density at 27°C	IS-7328-1974	gm/cm²	0.9425-0.9524
MFR	IS-7328-1974	gm/10min	0.4 to 1.1
Viscosity Number	ISD/R-1191	dl/g	300
Ultimate Tensile Strength	ISD/R-527	kgf/cm²	350
Elongation at break	IS-7328-1974	%	800
Notched Impact Strength	DIN 53453	Kgf/cm²	10
Coefficient of Linear Expansion between 20° and 90°C	DIN 52328	deg-c-1	2×10^{-4}
Dielectric constant (relative) at 50-106 HZ	DIN 53483	-	2.4 – 2.5
Crystalline melting range		deg°C	128 – 132

Major Characteristics of HDPE Pipes

a. Pipe resins are always copolymers. The quantity and type of the added comonomer determine the stress crack resistance of the pipe.

b. Densities for pipe resins will generally be in the range of 935 to 950 Kg/m³.

c. MWD (Molecular Weight Distribution) will generally be broad.

d. Melt indexes are generally below 0.3.

3.6 Laying and Jointing

All excavation work for laying HDPE pipes shall be done as described in section 3.1 in general. However, the special care must be taken to ensure that the hard objects like stones, rock pieces, tree roots etc. are not present. Pipes shall be bedded in sand or soft soil free from rock and gravel. Backfill upto 15 cm above the pipe shall also be of fine sand or soft soil. Pipes shall not be painted. The width of the trench shall be outside diameter of the pipe plus 30 cm. Pipes shall be laid atleast 90 cm. below the ground level (measured from surface of the ground to the top of the pipe).

HDPE pipes shall be butt jointed by heat fusion method in accordance with the following procedures. HDPE pipes shall not be threaded. Jointing procedure shall be as

follows and shall be strictly adhered to obtain optimum quality of joints. skillful application of qualified technique, welder and the use of proper construction equipment in good condition shall be made to achieve sound joints in HDPE piping.

3.7 **Preparation**

Any kinks or buckles in pipe near its ends shall be removed by cutting out as a cylinder. The face of the joints to be welded shall be flat. Correct position and holding of pipe is necessary when sawing pipe to achieve this. For pipes 160 mm. OD and above, shaping tool may be used.

Whether pipes have been sawn or not, joint faces shall be slightly scrapped with a knife, prior to welding, to remove exposed layers which may lead to unsatisfactory joint. Both the sections of pipe to be welded shall be positioned by using rollers and/or wooden supports.

3.8 **Welding**

Butt heat-fusion joint procedure shall require the use of jointing device (welding jack) that holds the heat element (mirror) square to the ends of pipes, can compress the heated ends together and holds the piping in proper alignment while the plastic hardens.

Temperature of joints should be 200^{o} C. Surface temperature, of the heating mirror, must, therefore, be 210^{o} C $\pm$ 5^{o} C. The faces of pipes to be joined shall be on either sides of the heating mirror and maximum of 0.4 kg/cm^2 contact pressure shall be applied. Contact pressure should not exceed this, otherwise the molten mass from the joint faces will be squeezed out prior to welding. Even with the lowest pressure a rim of molten material shall be formed on the ends of pipes being joined. Care shall be taken in the heating operation to prevent damage to the plastic material from over heating or having the material not sufficiently heated to ensure a sound joint. Direct application of heat, with a torch or other open flame is prohibited.

Approximate heating for series IV pipe may be taken as:-

32 mm OD pipe	:	1 minute
75 mm OD pipe	:	3 minutes
160 mm OD pipe	:	5 minutes

Heating time for pipes with lesser wall thickness may be according to experience and ambient temperature prevailing. Completion of heating is indicated by formation of a uniform rim of molten material at the edges of pipes.

Subsequent to heating, the pipes shall be removed from the heating mirror and shall be immediately joined by application of moderate pressure for 2-3 seconds, after which, pressure of approximately 0.6 Kg/cm^2 shall be applied for two minutes. After two minutes the pressure shall be increased to 1.2 kg/cm^2 and sustained for pipes upto 160 mm OD and 30 minutes for pipes 225 mm OD and larger.

Care shall be taken that the rim formed during welding is not too large. Pressure shall be maintained until the joint is hand-warm. After relieving pressure joint shall be allowed to cool completely before handling.

The electric heating mirror used shall be specially designed to meet the requirements of HDPE pipe welding. It should have a proper regulator to control and maintain its temperature during the welding procedure. It shall have P.T.F.E. cloth fitted on both sides to prevent adhesion of molten polyethylene on surface of the mirror.

Jointing Methods

Butt Welding is the only permanent joint. Technically and economically, it is the best method.

Tools Required: Welding Jack, Heating Mirror and other tools for beveling & cleaning and Hacksaw for cutting.

a. Cut the pipe straight, bevel and clean the inner edge and align the cut surfaces of the pipes.

b. Heat the mirror to 200°C electrically with temperature controller or with a kerosene blow torch and test the mirror temperature with thermochrome chalk.

c. Press the cut surface of the pipes to the two sides of the heating mirror and let the weld rims form.

d. Remove the mirror and press the heated ends together till they are fused with each other to form a Fusion Ring.

The outer and inner diameters at the ends of an HDPE pipe are reduced by shrinkage during cooling if the pipe is cut while it is hot. It is desirable to cut the pipes to be joined about 30 cm after either end before butt welding.

Pipe End & Flange Joint, as the name suggests, consists of a pipe-end (collar) butt-welded to the end of the pipe to be joined, and a backing / slip-on flange. Two such pipe ends are placed face-to-face with a rubber gasket and the flanges are tightened with nuts and bolts. The flanges can be made of plastic or metal. Plastic coating of metal flanges prevents corrosion and ensures longer life for the joint.

Cement Concrete for Pipe Supports:

Unless otherwise directed by the Construction Manager cement concrete for bed, all round or in haunches shall be in the mix 1:4:8 (1 cement : 4 coarse sand : 8 graded stone aggregate 40 mm nominal size):

	upto 1.5 m depth	**upto 3 m depth**	**beyond 3 m depth**
HDPE pipe	All round (1:2:4)	In Haunches (1:3:6)	In Haunches (1:3:6)
All pipes under building	All round (1:2:4)	All round (1:2:4)	All round (1:2:4)

Measurement:

a. Excavation: Measurement for excavation of pipes trenches shall be made per linear meter.

b. Trenches shall be measurement between outside walls of manholes at top and the depth shall be the average depth between the two ends to the nearest cm. The rate quoted shall be for a depth upto 1.5 metre or as given in the Bill of Quantities.

Payment for trenches more than 1.5m in depth shall be made for extra depth as given in the Bill of Quantities and above the rate for depth upto 1.5m

c. HDPE pipes shall be measured for length of the pipe line per linear meter:

i. Length between manholes shall be recorded from inside of one manhole or inside of other manhole.

ii. Length between gully trap and manhole shall be recorded between socket of pipe near gully trap and inside of manhole.

4. CONSTRUCTION OF MANHOLE

Where manholes are to be constructed, the excavation, filling back and ramming, disposal of surplus earth, preparation of bottom and sides etc. shall be carried out as described earlier under trench excavation. Manhole shall be sized and depths as called for in the drawings and Bill of Quantities.

The manhole shall be built on a base concrete 1:3:6 of 150mm thickness for manholes upto 1500mm depth and 250mm thickness for manholes from 1500 to 2500mm depth and 300mm thickness manholes of depth greater than 2500mm. Reinforcement as shown shall be provided in the base slabs.

The walls shall be of brick work of thickness as shown in drawings built in cement mortar 1:5. The joints of brick work shall be raked and plastered internally in cement mortar 1:3 (at least 12 mm thick) and finish with a coat of neat cement, external plaster shall be rough plaster in 1:3, PCC benching & semi circular channels of the same diameter as the pipes shall be provided and finished with neat cement coating.

Above the horizontal diameter, the sides of channel 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 an appropriate fall suitably rounded off in the direction of flow in the main channel shall be given. All manholes / sumps shall be provided with poly propylene coated steel reinforced foot rest. The polypropylene shall confirm to ASTM D-4101 specification, injection moulded around 12 mm dia IS-1786 grade FE-415 steel reinforcing bar. These rungs shall be set at 30cms interval in two vertical runs at 380mm apart horizontally. The top rung shall be 450mm below the manhole cover. Unless otherwise mentioned, manholes shall be constructed to the requirements of Indian Standard IS:4111 (Part I). All manholes shall be constructed so as to be water tight under test. All angles shall be rounded to a 75mm radius with cement plaster 20mm thick. The benching at the side shall be carried out in such a manner so as

to provide no lodgment for any splashing in case of accidental flooding. Manhole cover with frame shall be of cast iron of an approved make. The covers and frame shall generally be double seal as specified in the Bill of Quantities.

4.1 **Measurements**

Manhole shall be measured in numbers as indicated in the Bill of Quantity. The depth of manhole shall be measured from invert of channel to the top of manhole cover.

Manhole with depth greater than specified under the main item shall be paid for under `Extra Depth' and shall include all items as given for manholes depth will be measured to the nearest cm. Depth of the manholes shall be measured from top of the manhole cover to bottom of channel. The following are inclusive in the cost of manhole viz;

i. Bed concrete
ii. Brick work.
iii. Plastering (inside & outside)
iv. R C C top slab, benching and channeling including drop connections.
v. Supply and fix foot rests.
vi. Keeping holes and embedding pipes for all the connections.
vii. Excavation, refilling, necessary de-watering and disposing off surplus soil to a places as directed by Project Manager.
viii. Curing.
ix. Cost of angle frame and embedding the frame in concrete bed.
x. Testing.
xi. De-watering of chambers.

4.2 **Drop Connection**

Drop connection shall be provided between branch sewer and main sewer in the main sewer itself in steep ground when the difference in invert level of two exceeds 60 cms of the required sizes. Drop connections from gully traps to main sewer in rectangular shall be made inside the manholes and shall have CI special types door bend on to top and heel rest bend at bottom connected by a CI pipe. The pipe shall be supported by holder bat clamps at 180 cms intervals with atleast one clamp for each drop connection. All joints shall be lead caulked joints 25mm deep.

Drop connections from branch sewer to main sewer shall be made outside the manhole wall with CI / CI class LA pipe, connection, vertical pipe and bend at the bottoms. The top of the tee shall be finished upto the surface level and provided with a CI hinges type frame and cover 30cms x 30cms. The connection and tee upto the surface chamber of the tee.

Drop connection made from vertical stacks directly into manholes shall not be considered as drop connections.

4.3 **Making Connections**

Contractor shall connect the new sewer line to the existing manhole by cutting the walls benching and restoring them to the original condition. A new channel shall be cut in the

benching of the existing manhole for the new connection. Contractor shall remove all sewage and water if encountered in making the connection without additional cost.

5. GREASE TRAP

5.1 **Size of Grease Trap**

The size given in Bill of Quantities and drawings shall be internal size of chamber. The work shall be done strictly as per standard drawing and following specifications.

5.2 **Bed Concrete**

Shall be in 1:4:8 cement concrete 150 mm thick.

5.3 **Brick work**

Brick work shall be with best quality bricks in I:5 CEMENT MORTAR.

Baffle walls shall be of R.C.C and of size as mentioned in Bill of Quantities. Brick partition constructed of best quality table moulded bricks in cement mortar 1:5 shall be provided for the entire height of chamber.

5.4 **Plaster**

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.

5.5 **Chamber Covers**

Covers shall be of size and duty as mentioned in Bill of Quantities. 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.

5.6 **Cast iron Manhole cover and Frame**

The Cast Iron Manhole Cover and Frame shall conform to IS:1726 and the grade and types have been specified in the Bill of Quantities. 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 checkered 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.

6. TESTING

All rights of the sewer and drain shall be carefully tested for water tightness by means of water pressure maintained for not less than 30 minutes. Testing shall be carried out from manhole to manhole. All pipes shall be subject to a test pressure of 1.5 meter head of water. The test pressure will however, not exceed 6 meters head at any point. The pipes shall be plugged preferably with standard design plugs or with rubber plugs on both sides, the upper end shall, however, be connected to a pipe for filling with water and getting the required head poured at one time.

Sewer lines shall be tested for straightness by:

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

ii. Means of a mirror at one end a lamp at the other end. If the pipe is straight the full circle of light will be seen otherwise obstructions or deviations will be apparent.

iii. The contractor shall give a smoke test to the drain and sewer at his own expense and charges, if directed by the Owner's site representative.

iv. A test register shall be maintained which shall be signed and dated by contractor and Owner's site representative.

SECTION - 06 :: HYDROPNEUMATIC SYSTEM & PUMPING MAINS

1. SCOPE

This section of the contract involves the design, supply, installation, testing and commissioning of the complete Hydropneumatic pumping system and other pumping systems complete with all controls and electrical work for domestic water supply, water supply for flushing and for cooling tower make-up. All submersible water re-circulation, drainage and ejector pumps for the project are also included in this contract. It also involves testing and commissioning of the pumping system with the domestic water and flushing water supply & distribution.

This specification described the particulars of the contract, designs and systems chosen, and mode of operation.

All installation work shall comply with the latest rules and regulations.

The work embraced by this specifications covers the design, submission to authorities, supply, delivery on site, installation, testing, commissioning and maintenance of the Hydropneumatic pumping system, other pumping system installation of the building in accordance with this specification and associated drawings.

The scope of work shall include the following (list is indicative and not exhaustive) :

- Variable speed pumping units domestic water & flushing water supply & distribution.

- Suitably sized food grade quality, non-toxic diaphragm type pressure vessels complete with necessary interconnections and controls.

- Control panel for pump control complete with variable speed drives, circuit breakers, fusses, pressure transmitters etc. complete with all interconnections to pumps and electrical supply panels.

- Pump control units complete with pre-programmed micro-processor chip.

- Pump monitoring units to monitor operation of pumps.

- Each Hydropneumatic Pumping unit shall be supplied as a complete set including variable speed pumps, pressure vessels suction and discharge common manifolds, non-return valves, isolating valves, pressure transmitters on the discharge side and level electrode at the suction tank. Each unit shall be provided with electronic microprocessors for unit control and all necessary electrical work for the unit.

- Submersible water re-circulation pump for water fountain, drainage pumps for plant room drainage complete with electrical panels and necessary accessories with automation for pump operation.

- All the pipework etc. shown in the system drawings is meant for information only and shall be carried out by others. The Hydropneumatic system supplier shall provide the pumping units in the designated pump rooms as complete units included all necessary piping within plant such that only discharge connections are required to be connected into the unit’s discharge manifolds just inside the plant room, by the Plumbing contractor. The Hydropneumatic system contractor shall guarantee specified pump performance at various pump speeds and Hydropneumatic pumps must be able to supply at least 2 bar pressure at the highest/farthest fitting.

- Electrical equipment and installation work including the PLC in Control panel.

- Painting and labelling of pipe work and equipment;

- Provision of all hold down bolts, spigots struts and the like required to be built in during construction;

- Provision of dry contacts to BMS indicating the status of the pumps and pressure vessel in form of hardware interfacing panels inside each pump room and control panels of all pumps.

- Provision of all level switches, flow switches and other sensing devices for status indication.

- All interfacing work with other trades.

- Testing & commissioning and balancing of the Hydropneumatic & Pumping system;

- Provision of twenty four (24) months operational maintenance and breakdown services;

- Provisions of operating instructions and maintenance manuals;

- Provision of spare parts;

- Training of the employer's staff for proper operation of the entire systems;

- Liaison with Local Authorities to obtain all necessary certificates and approvals, including the completion of all submission drawings, forms and payment of any fees and charges. All the costs for all the tests required by Local Authorities shall be included. To attend to any Authorities inspection regardless of whether this inspection is carried out after the defect liability period;

- Provisions of the necessary installation which include pumping works, pipe work within the pumping unit up to suction and discharge manifolds, conduit and control wiring, etc. to form a workable system required;

- All other works and systems as specified in the Contract document and or shown on the drawings.

- All cutting, patching, framing up, furring in, chasing and making good associated with the building construction for the passage of pipes, conduits and the like including providing GI pipes sleeves of required size corresponding to pipe dia, wherever pipes crossing fire rated walls and floors and sealing with glass wool in between and fire sealant compound on either end. Details on shop drawings shall also be provided.

2. GENERAL

Equipment offered for supply and installation shall include the following:

All minor items and incidental work, equipment accessories and materials may not be specifically mentioned but are required for the proper completion of the installations in accordance with the true intent and meaning of this Specification.

All necessary safety devices for the protection of personnel against injury and the protection of plant and equipment against damage including relief valves, belt guards, fan inlet and/or discharge guards, safety railing, effective earthing of electrical components, electrical interlocks, warning lights and alarms.

Readily accessible, dust-proof lubricating facilities on all moving parts and equipment including provision for cleaning all lubricating lines and bearings and charging same with the correct lubricants after installation but prior to testing and commissioning.

Clearly visible and robust manufacturer's name-plates permanently fitted each and every item of equipment and showing the manufacturer's name, type and/or model number, serial number, and all essential operating data such as speed, capacity, voltage, current draw, etc.

The Contractor also shall allow provision for the inspection of all plant and equipment by the manufacturer or his licensed representative, at least twice during the course of the installation.

3. PIPING

The pipes and fittings in the domestic Water Treatment plant room shall be GI class `C' (heavy class) conforming to IS: 1239 (Part-I) for pipes and IS:1879 (Part 1 to 10) for malleable cast iron galvanized fittings.

All drainage / burried piping shall be cast iron pipes (CI Class LA) as per IS:1536 and fittings with ty-ton joints complete with required accessories (Fittings shall be of lead joints).

4. PUMPS FOR HYDROPNEUMATIC & DRAINAGE SYSTEM

4.1 **Pumps**

Pumps shall be vertical, centrifugal, multistage directly coupled to motor. Provision of pump with pump head & base of cast iron and other parts in SS 304 shall be made for pumps required in Hydropneumatic System and water fountain re-circulation system. Impeller shall be hydraulically balanced and keyed to shaft. Pump shall be mounted on a concrete foundation, projecting at least 15 CM above finished floor level. The pumps base shall be set on a vibration elimination pad. The pump shall be lubricated in strict accordance with the manufacturer's instructions and shall be factory aligned prior to shipment. All motors and bases shall be painted with approved finish shop coat of paint. The pump shall be selected for the lowest operating noise level and shall be complete with flexible connections, valves, and pressure gauges. The pumps shall include cost of foundation channel complete.

The Contractor shall supply and install pumps of the type and performance as shown on the drawings. All duties of pumps given in the Tender Drawings shall be checked and where necessary corrected before ordering. All the parts of the pumps that are in contact with water e.g. shaft, impeller etc. shall be of stainless steel construction.

Pumps shall be so selected that the design duty point is within 5% of the maximum efficiency point. The pump casing so selected shall have ample space to take an impeller one size larger than that capable of performing the design duty.

The pump shall have a speed of not more than 1500 rpm. However pumps of 2900 rpm with high efficiency and low noise motor can be selected and noise data submitted for approval. All pumps and motors shall be of minimum vibration and noise level during operation. Vibration isolators shall be provided for all pump sets.

Facilities shall be provided to prevent starting of pumps when the water tank is at low water level. An indicator for this low water level alarm shall be provided.

Facilities to select which pump to be duty pump and standby pump shall be provided and be interchangeable.

Leakage from pump gland shall be drained to the nearest floor waste.

Pump curves for all pumps offered shall be submitted. All curve indicating excessive shut-off head will not be approved.

Each pump shall be provided with a gate valve at suction and discharge, approved check valve at discharge, approved strainer at suction, flexible connections at pump suction and discharge,

eccentric reducer at suction, concentric reducer at discharge, pressure gauges at suction and discharge, circulation relief valve and automatic air relief valve.

Appropriate neoprene vibration isolation mountings shall be provided for each pump sets.

Vertical Multi-Stage Pumps

Multi-stage pumps shall be of centrifugal type and arranged with shafts vertically installed. The impellers shall be of stainless steel mechanically balanced and keyed to shaft. Renewable guide rings are to be provided in the casting, keyed to prevent rotation.

Pumps shall be driven by elevated in-line TEFC squirrel cage motors via extended vertical shafted complete with universal couplings.

The shafts shall be stainless steel. Stainless steel sleeves shall be provided to protect the shaft in the water space and through the sealing glands. The sleeves shall be keyed to prevent rotation and secured against axial movement.

The bearings shall be of ball or roller type protected against ingress of water, dirt and other matter.

Vertical multistage pumps shall have universal flanges. Intermediate bearing, support bearing shall be provided in the pump.

The shaft seal shall be easily serviceable and shall allow for correct adjustment and loading of the seal. Pump motors above 7.5 kW shall be equipped with a spacer coupling which allows changing of shaft seals without removing the motor. The pump motors shall be of Class “F” insulation and IP55 rating and shall be provided with built-in thermistors for protection against over heating.

4.2 Variable Speed Hydropneumatic Pumping System

Variable speed Hydropneumatic pumping units shall be provided for supply of domestic water, flushing water supply for the project. The units shall be selected so as to provide at minimum of 2 bar pressure at the highest/farthest fitting in each plumbing system, the unit serves. The hdyropnematic pumping units shall have the following features ;

4.2.1 System Description

The system shall be supplied as complete sets including suction and discharge common manifolds, non-return valves, isolating valves, pressure transmitter on the discharge side and electrode at the suction tank.

The system operation will be such that the initial small water demand shall be met by the charged diaphragm pressure vessel. Should the water demand continue the system pressure will dip to a preset pump cut-in point when the lead pump starts to operate at reduced speed through the variable speed drive. However, should the system pressure be still below the preset value, the controller continuously increases pump speed to meet the system demand. When the lead pump is not able to meet the system pressure at full speed, the second pump also starts to operate.

At peak demand all the pumps operate, similarly, if there is a drop in water demand the duty pump speed starts to reduce, then standby pumps cuts-off, followed by stopping of the duty pump.

The closed diaphragm pressure vessel shall be of polyethylene material with a pressure gauge and isolating valve. The interior shall be of non-toxic lining suitable for use with potable water. The vessel shall be manufactured to conform to ASME pressure vessel code/standards.

The system shall be under the control of an electronic microprocessor unit (EMU).

A pressure transmitter shall detect the pressure at the delivery manifold and feedback to the microprocessor control panel via control circuit.

The system shall incorporate a frequency converter or frequency converter motors on the pumps and the pressure transmitter shall register the actual pressure on the discharge side.

The variable speed drive pumping system shall maintain a constant pressure regardless of the system demand. If there is a drop in pressure outside the preset point, the Variable Speed Drive (VSD) pump shall start to run until the pressure increases to the preset limit, or it will continue to increase the pump speeds to the upper limit of the frequency. If the water system demand still cannot be met, the second pump shall be called in to run, the VSD will then alter the pump speed to meet the preset pressure point. If the set point is still unable to be met, the third pump is then activated to run (in case of 3 pumps units).

This shall be achieved by continuously varying the motor speed of the duty pump according to the demand up to a maximum designed capacity.

Under decreasing hydraulic demand the reverse sequence to the above description shall apply.

The EMU shall ensure alternation of all the duty and standby pumps for even running hours for all the pumps.

The frequency converter shall be linked to the motor of the duty pump for continuous speed adjustment and ultimately the water delivery shall be maintained at constant pressure at the preset value.

4.2.2 Local Motor Control Panel

The motor control panel shall be equipped with all the necessary electrical components including a microprocessor control unit and a frequency drive. The control panel and the microprocessor shall cover the followings functions :

- Flexibility and simplicity in allowing the necessary re-adjustment of the pumping system pre-set delivery pressure to operate the pumps within the specified maximum and minimum delivery ranges.

- Built-in frictional loss compensation factor which will automatically increase the delivery pressure setting, in collaboration with the increase in flow demand. This shall be able to minimise the system pressure differences and provide a more constant pressure along the supply line and also to save the energy consumption of the motor when running at low speed.

- Automatic changeover of the pumps to be controlled by the microprocessor which dictates the duty and standby pumps to run at variable speed.

- Built-in clock functions with weekly programming and with switch on system to operate at least 10 different pre-set pressure points as required.

- When the system has not been operated for more than 24 hours, it shall automatically start the pumps for a few seconds/day to ensure the pumps readiness at all times. The standby pumps shall be activated upon failure of duty pump(s). In event of control failure, the pumps shall be able to be start/stopped manually at the local panel by means of pressure switches.

- The microprocessor control panel shall be able to cut-off the pumping system when excess pressure is registered in the discharge common manifold.

- The system shall have the capability of receiving input signal concerning reduced water level in suction tanks and shall have control mechanisms to prevent the pumps form running dry.

- Automatically starting the pumps when the water level is back to normal.

- In case of pump failure due to motor overload, the standby pump is switched on automatically. Alarm signal is displayed on the LCD Display unit and alarm lights are activated.

- Functions to limit the no. of start/stop of pumps per hour.

- The system control panel shall incorporate at least the following components :

  a. LCD Display

  b. Pumps selections for up to 4 pumps so that system controller can control up to 6 pumps

  c. Pump status button to display duty pump speed and system capacity

  d. Zone status button to display operating parameters for different pumping units

  e. Setting button to input preset pressure, system start/stop time etc.

  f. ±1 button to key in numeric data such as pressure set point, etc.

  g. Enter button for confirmation of input into the system

h. Alarm button to show location of fault - self diagnostic function display

i. Hour Run measurement for each supplied pumpset

j. Buttons for scrolling to select the actual display reading for system configuration, i.e. up and down scroll concept.

k. Necessary devices for programming, supervising and monitoring operation data/system, status shall be incorporating into the control panel.

4.2.3 Operations

Local control panel shall perform as follows :

Auto mode

The desired delivery pressure within the range specified, shall be set at the duty local control panel. The pressure transmitter shall detect the delivery pressure continuously within 1 second and feedback to the microprocessor which will control the variable speed drive frequency converter for speed control of the duty pump. When demand increases, the subsequent pumps in the system will be activated to boost up the pressure. Ultimately the duty pumpset shall be operated fully automatically to maintain the delivery pressure constantly at the desired set value.

Manual Mode

The on/off function of the pumps shall be manually adjusted at the microprocessor located at the local control panel.

Frequency Control By-pass Mode

All the pumpsets shall be started/stopped automatically with the pump output at fixed maximum rotational speed. All the control and protection functions shall remain active. The cut in/cut out pressure shall be internally calculated by the microprocessor for each pump.

4.2.4 System Features

The required performance features of each Hydropneumatic pumping unit shall be as follows :

System Configuration

Variable speed pumps with pressure vessels.

Control panel consisting of the following components :

- Pump Functional Unit (PFU) - control unit c/w pre-programmed microprocessor chip. This unit shall control all pumping unit operations through electronic controller.

- Pumping Monitoring Unit (PMU) - monitor the operation of the pumpsets. This unit shall allow for monitoring and setting of all control parameter.

- Variable Speed Drive

- Circuit Breakers

- Fusses

- Pressure Transmitter

Set Point

Ten separate pressure "set points" shall be able to be programmed into the PMU, and switching between set points is timed by a real time clock when a lower pressure is acceptable during certain periods, for instance after hours or weekends, the set point shall be lowered to minimise power consumption.

An external input shall also be used to switch between set points, or manually adjust a set point at any time.

Friction Loss Compensation

It shall be possible to allow for the friction loss component of the system, calculated at full flow and set as a percentage of the set point which will reduce the working pressure of the pump set depending on the actual no. of pumps in operation. A linear approximation of system resistance curve can therefore be allowed for, and pressure will automatically increase as system flow and subsequent frictional losses increase. As such power consumption shall reduce which is required for the pumping system.

Displays

Through the PMU keypad all variable parameters shall be adjustable, current status of settings and measured values shall be able to display on the 2 line x 24 character liquid crystal display.

Individual menus shall be available for monitoring individual pumps, zones, settings, alarms and ON/OFF functions.

Pump Status

Running hours of each pump
Actual pump status (running, not available, standby, allocated to zone, fault)
Maximum head of pump at zero flow.

Zone Status

This menu shall be the main operating menu where at the setting and operating parameters can be viewed,

- Current operating set point
- Measured values in the system
- Operating capacity in terms of total output
- Mode of operation for the zone
- Clock programs (relating to set point pressures)
- Standby pumps
- Pump change over time
- Zone configuration
- Pressure transducer scaling
- Friction loss compensation
- Pump priority
- Inlet pressure measuring (if required)
- System response times
- Allowable number of starts per hour for the pumps
- Minimum limit (loss of water, burst mains protection)

Setting Menu (Set)

In this menu all parameters for the operation of the pump set shall be able to be adjusted as required.

a Set points (up to 10)
b. On/Off function (used to prevent unnecessary cycling at low demands)
c. Displayed pressure units (Bar, PSI, mBar, kPa)
d. Real time clock programming for any time of the day, week, or weekend
e. Zone configuration
f. Friction loss compensation

Alarm

The alarm menu shall display all faults that occur during operation, logging the time and date of when the fault occurred and when it was corrected, or whether it is still an actual fault, up to 10 faults can be maintained as history in the controller. The following type of faults shall be diagnosed by the controller.

a. Mains failure
b. Frequency converter fault
c. Analogue input (pressure transducer) fault
d. High discharge pressure fault
e. Low discharge pressure fault
f. Motor thermal overload fault

Variable Frequency Drive

Variable frequency drive shall be of a reputable make acceptable to Project Manager and shall be complete with RFI filter and harmonic dampers.

Enclosure

An IP 54 powder coated steel enclosure shall house all the electrical components.

The enclosure can be supplied loose for remote mounting, or mounted on a common base with the pumps, it shall be adequately ventilated for use in conditions up to a maximum ambient temperature of 45 degrees Celsius.

Electrical Component

All circuit breakers, thermal overloads and contactors shall be of reputable make acceptable to the architect. Electrical supply to the pump controller shall be protected using an isolating circuit breaker.

Method of Starting

The panel shall be built to start the pumps in suitable starting modes, i.e. D.O.L., Star/Delta, or using Soft Starters.

Quality and Testing

Manufacture of the pumps, plus design and assembly of the complete packaged Hydropneumatic pumping system shall be factory assembled and the pump station shall be fully tested hydraulically and electrically prior to dispatch to site. Test reports etc. shall be submitted for review before dispatch.

4.2.5 Pump Pressure Vessel

Diaphragm type pressure vessels shall be provided as shown on the drawings. They shall be incorporated into the system so that during normal operation the pump shall not need to be start within 30 seconds of it switching off in order to prevent the pump hunting.

The pressure vessel shall be of adequate capacity to accommodate a considerable fluctuation in water demand by the system with minimum start/ stop cycles of the pumps. The vessel shall be constructed of steel plate built to ASME Standards for Unfired Pressure Vessel. A rubber diaphragm shall be provided in the vessel for separating the water and pre-charge nitrogen. The pre-charge pressure shall be adjustable and charging port with non-return device shall be provided. The adjustable cut-in and cut-off pressure unit for the pumps shall be built-in at the vessel to suit the system.

4.3 **Floatless Type Level Switch in Water Tanks**

The Contractor shall supply and install float less type switch probes in the water tanks as indicated below and shown on the drawings.

Raw Water Tanks at Basement

· High level alarm (over-flow);
· Low level alarm;
· Low level cut-out for raw water pumps;
· Earthing probe.

Cooling Tower Make-up

· High level alarm (over-flow);
· Low level alarm;
· Low level cut-out for cooling tower makeup water supply pumps;
· Earthing probe.

Potable Water Tank at Basement Level

· High level alarm (over-flow);
. Low level alarm;
. Low water level cut-out for the domestic hydropneumatic pumps;
· Earthing probe.

Each probe shall be of the correct length for the particular application and tank location. Electrodes shall be of polished stainless steel 20 mm OD. Electrode holders shall be weatherproof in all respect.

The earthing probes shall be connected and wired to the building earth systems of the building.

Each set of electrodes shall be installed inside a 230 mm diameter PVC pipe acting as a wave barrier.

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

Mechanical steel stuffing boxes shall be used.

Control of Duty / Standby Pumps

Operation of the duty and standby pumps shall be carried out by the following method:

a Automatically by means of pressure sensor (i.e. pressure switches);

b Manually by means of a local start/stop push buttons on pump local motor control panel and emergency stop switch.

The pressure switch shall be installed next to the manual release valve. When the pressure drops to the pre-determined level, a signal will be sent to the pump local motor control panel to start the pump.

Automatic controls shall be operated by electronic, float less type level switches.

Pump Indicator

The following audible and visible indication shall be provided at the pump local control panels as applicable:

a. Red "overflow level" indicator with buzzer for the associated water tanks;

b. Amber "extra high water level" indicator for the associated water tank;

c. Amber "high water level" indicator;

d. Amber "low water level" indicator;

e. Red "pump trip" indicator for each pump;

f. Green "pump on" indicator for each pump;

g. "Pump electrical supply healthy" indicator for each pump;

h. Amber "remote/local" status indicator.

4.4 **Sump Pump**

4.4.1 Submersible

These shall be fully submersible with a fully submersible motor. The pumps shall be provided with an automatic level controller and all interconnecting power and control cabling which shall cause the pumps to operate when the water level in the sump rises to a preset level and stop when the preset low level is reached.

Pumps for drainage shall be single stage, single entry.

Pump shall be C.I. casing and C.I. two vane open type with a dynamically balanced impeller connected to a common shaft of the motor. The vane for sewage pump will be open type, while for drainage pump, etc. it will be of semi open type. The MOC of the sump shall be in accordance to schedule of quantity.

Stuffing box shall be provided with mechanical seals.

Each pump shall be provided with a suitably rated induction motor suitable for 415 volts, 3 phase, 50 Hz A.C. power supply.

Each pump shall be provided with in built liquid level controller for operating the pump between predetermined levels.

The pumping set shall be for stationary application and shall be provided with pump connector unit. The delivery pipe shall be joined to the pump through a rubber diaphragm, and bend and guide pipe for easy installation.

Pump shall be provided with all accessories and devices necessary and required for the pump to make it a complete working system.

Sump pump shall be complete with level controllers, power and control switch gear, Auto/off/Manual switches, pumps priority selections and control and power cabling upto motor and controller/probes etc. (Including earthing). Level control shall be such that one pump starts on required level, 2nd pump cuts in at high level and alarms is given at extra high level. All level controllers shall be provided with remote level indications.

4.4.2 Motor Design

The pump motor shall be a squirrel cage induction, housed in air filled water-tight enclosure. Oil filled motors are not acceptable. The stator windings shall be Class "F" insulation (155 degree C or 311 degree F) for general usage and class `H' insulation (180 degree C or 317-8 grade 2) for submersible type.

The stator shall be heat shrunk fitted into the enclosure and shall not use bolts, pins or other fasteners that penetrate through the stator enclosure. The starter shall be equipped with a thermal switch embedded in series in the coils of the stator windings to protect the stator from wheel.

The motors shall be designed for continuous running duty type at 415 volts, 3 phase, 50 Hz power supply and capable of sustaining a minimum of 20 starts/stops per hour.

Between stator housing and pump, a tandem seal arrangement will be provided with an oil barrier. Both seals run in oil, allowing dry running without seal damage. Both seals shall be of the rubber bellows or metallic bellow type with positive drive between shaft and rotating seal face.

SECTION - 07 :: WATER TREATMENT SYSTEM & ACCESSORIES

1. SCOPE

This section of the contract involves the design, supply, installation, testing and commissioning of the complete Water Treatment plant for domestic water.

All installation work shall comply with the latest rules and regulations.

The work embraced by this specifications covers the design, submission to authorities, supply, delivery on site, installation, testing, commissioning and maintenance of the Water treatment system installation of the building.

The scope of work shall include the following (list is indicative and not exhaustive) :

- Complete Raw Water Treatment System. The Contractor shall be responsible for carrying out water analysis for the raw water from borewell / tanker supply and design all system components/equipment so as to achieve the potable water quality as per specified Standards SP:35 (S&T 1987) & IS 10500.

- The Raw Water Treatment System as a minimum shall consist of feed pumps, filters with back wash provisions with all accessories complete with all controls, softner, PH automatic control and monitoring system, electrical panels, cabling, etc.

- All the pipework between the raw water tanks, treated water tanks and all the interconnecting pipework amongst the Water Treatment pumps and other equipment.

- Electrical equipment and installation work including the necessary wiring etc. in Control panel.

- Painting and labelling of pipework and equipment;

- Provision of all hold down bolts, spigots struts and the like required to be built in during construction;

- Provision of dry contacts to BMS indicating the status of the pumps and pressure vessel in form of hardware interfacing panels inside each control panels of all pumps.

- Provision of all level switches, flow switches and other sensing devices for status indication.

- All interfacing work with other trades.

- Testing and commissioning and balancing of the complete Water Treatment system;

- Provision of twelve (12) months maintenance and breakdown services;

- Provisions of operating instructions and maintenance manuals;

- Provision of spare parts;

- Training of the employer's staff for proper operation of the entire systems;

- Liaison with Local Authorities to obtain all necessary certificates and approvals, including the completion of all submission drawings, forms and payment of any fees and charges. All the costs for all the tests required by Local Authorities shall be included. To attend to any Authorities inspection regardless of whether this inspection is carried out after the defect liability period;

- Provisions of the necessary installation which include pumping works, pipework within the pumping unit up to suction and discharge manifolds, conduit and control wiring, etc. to form a workable system required;

- All other works and systems as specified in the Contract document and or shown on the drawings.

- All cutting, patching, framing up, furring in, chasing and making good associated with the building construction for the passage of pipes, conduits and the like including providing GI pipes sleeves of required size corresponding to pipe dia, wherever pipes crossing fire rated

walls and floors and sealing with glass wool in between and fire sealent compound on either end. Details on shop drawings shall also be provided.

2. GENERAL

Equipment offered for supply and installation shall include the following:

All minor items and incidental work, equipment accessories and materials may not be specifically mentioned but are required for the proper completion of the installations in accordance with the true intent and meaning of this Specification.

All necessary safety devices for the protection of personnel against injury and the protection of plant and equipment against damage including relief valves, belt guards, fan inlet and/or discharge guards, safety railing, effective earthing of electrical components, electrical interlocks, warning lights and alarms.

Readily accessible, dust-proof lubricating facilities on all moving parts and equipment including provision for cleaning all lubricating lines and bearings and charging same with the correct lubricants after installation but prior to testing and commissioning.

Clearly visible and robust manufacturer's name-plates permanently fitted each and every item of equipment and showing the manufacturer's name, type and/or model number, serial number, and all essential operating data such as speed, capacity, voltage, current draw, etc.

The Contractor also shall allow provision for the inspection of all plant and equipment by the manufacturer or his licensed representative, at least twice during the course of the installation.

3. FILTRATION

3.1 **Scope**

The scope of this section comprises the supply, installation and commissioning of FRP composite vessel filter.

3.2 **MS Composite Vessel Filter**

The filter shall be constructed of MS material with inner shell of integrated polyethylene, polypropylene and other material as per manufacturer's standard.

The inter distribution system and the underbed draw off system shall be of Hub & Lateral type of polypropylene material. The filter shall be provide with manhole cover, hand hole, flanged outlet for piping / valve connection and adequate tripod with skid self supporting structure for making the installation completed. The filter shall also be provided with vacuums breaking connection / accessories to avoid any collapse of internal lining. All filters shall be provided with lifting lugs. The filter bed depth shall be 1500 mm.

3.3 **Face Piping**

Each filter shall be provided with interconnecting face piping comprising of inlet, outlet, and backwash complete with valves.

3.4 **Accessories**

Each filter shall be provided with following accessories:-

a. Air release valve with connecting piping.

b. 100 mm dia dial bourden type gunmetal pressure gauges with brass isolation ball valve and connection piping on inlet and outlet.

c. Sampling valves (ball valves) on raw water inlet and filtered water outlet.

d. Individual drain connection with brass fullway ball valve for each filter.

3.5 **Filter Media**

The filter media shall comprise of gravel / silica of various grade in varying thickness. The cut-section of the filter along with filter media detail shall be subject to approval by the Consultant.

3.6 **Test Kits (Optional)**

Provide one test kit with initial requirement of reagent:

a. PH meter (electronic)
b. Turbidity meter

Detail of equipment with technical literature shall be supplied with the tender.

3.7 **Piping**

The pipes and fittings in the domestic Water Treatment plant room shall be GI class `C' (heavy class) conforming to IS: 1239 (Part-I) for pipes and IS: 1879 (Part 1 to 10) for malleable cast iron fittings.

4. PUMPS

Pumps shall be vertical, centrifugal, multistage directly coupled to motor. Provision of pump with pump head & base of cast iron and other parts in SS 304 shall be made for pumps required in Hydropneumatic System, swimming pool system. Impeller shall be hydraulically balanced and keyed to shaft. Pump shall be mounted on a concrete foundation, projecting at least 15 CM above finished floor level. The pumps base shall be set on a vibration elimination pad. The pump shall be lubricated in strict accordance with the manufacturer's instructions and shall be factory aligned prior to shipment. All motors and bases shall be painted with approved finish shop coat of paint. The pump shall be selected for the lowest operating noise level and shall be complete with flexible connections, valves, and pressure gauges. The pumps shall include cost of foundation channel complete.

5. ALUM / SODA ASH DOSERS

All dosers shall be of the electronic metering plunger type confirming to the requirements specified in the Bill of Quantities. They shall be complete with low level switch, low level alarm, tank and interconnecting piping.

6. UV UNIT

UV unit shall be complete with reactor, cabinet housing, cabinet cooling, treatment chamber, electrical panel, temperature safety control, lampout alert, UV radiometer along with UV monitoring system and UV monitoring readout panel. The UV Dosage should be > 30,000 uW – Sec / sq.cm. The lamps should be selected based upon the flow requirement of respective unit.

7. WATER QUALITY

The domestic water treatment basis of design is as per raw water analysis.. Contractor shall get the raw water analysis done at his own expense (in accordance to IS:10500 prior to submission of the water treatment scheme.

The contractor shall ensure domestic water of potable water standard after the treatment system. The acceptable standard of potable water shall be in accordance to SP:35 S & T : 1987 as per acceptable limits.

The technical tolerances for water shall be as follows:

S. No.	**Characteristic**	**Tolerance**
i.	PH value	7.5 to 8.5
ii.	Total alkalinity (as CaCOs), mg/1, Max	50 to 500
iii.	Aluminium (as A1), mg/1, Max	0.1
iv.	Total residual chlorine, mg/1 a. At inlet, Max b. At outlet, Min	 0.5 0.2
v.	Oxygen absorbed in 4 hours at 27 deg.C mg/1, Max	1.0
vi.	Chloride (as CI), mg/1, Max	500
vii.	Iron, mg/1, Maxx	0.1
viii.	Heavy metals (as pb), mg / 1, Max	0.1
ix.	Colour, Hazen units, Max	10
x.	Turbidity, NTU, Max	10
xi.	Odour	Odourless
xii.	Taste	Palatable

8. FLOATLESS TYPE LEVEL SWITCH IN WATER TANKS

The Contractor shall supply and install floatless type switch probes in the water tanks as indicated below and shown on the drawings.

Raw Water Tanks at Basement

- High level alarm (over-flow);
- Low level alarm;
- Low level cut-out for raw water pumps;
- Earthing probe.

Treated Water Tank at Basement Level

- High level alarm (over-flow);
  Low level alarm;
  Low water level cut-out for the hydropneumatic pumps;
- Earthing probe.

Each probe shall be of the correct length for the particular application and tank location. Electrodes shall be of polished stainless steel 20 mm OD. Electrode holders shall be weatherproof in all respect.

The earthing probes shall be connected and wired to the building earth systems of the building.

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

9. CONTROL OF DUTY / STANDBY PUMPS

Operation of the duty and standby pumps shall be carried out by the following method:

a. Automatically by means of pressure sensor (i.e. pressure switches);

b. Manually by means of a local start/stop push buttons on pump local motor control panel and emergency stop switch.

The pressure switch shall be installed next to the manual release valve. When the level drops to the pre-determined level, a signal will be sent to the pump local motor control panel to start the pump.

Automatic controls shall be operated by electronic, floatless type level switches.

10. PUMP INDICATOR

The following audible and visible indication shall be provided at the pump local control panels as applicable:

a. Red "overflow level" indicator with buzzer for the associated water tanks;
b. Amber "extra high water level" indicator for the associated water tank;
c. Amber "high water level" indicator;
d. Amber "low water level" indicator;
e. Red "pump trip" indicator for each pump;
f. Green "pump on" indicator for each pump;
g. "Pump electrical supply healthy" indicator for each pump;
h. Amber "remote/local" status indicator.

11. UV UNIT

UV unit shall be complete with reactor, cabinet housing, cabinet cooling, treatment chamber, electrical panel, temperature safety control, lampout alert, UV radiometer along with UV monitoring system and UV monitoring readout panel. The UV Dosage should be > 30,000 uW – Sec / sq.cm. The lamps should be selected based upon the flow requirement of respective unit.

12. CHEMICAL & BACTERIOLOGICAL / MICROBIOLOGICAL TEST PARAMETER OF RAW METER

The above mentioned parameters shall be tested in accordance to :

IS : 10500 – 1991, Amendment No : 2-2003

The Chemical and Physical Parameter (30 Parameters) shall be as follows :

Colour, Odour, Turbidity, Total Hardness, pH, Total Iron, Chloride, Dissolved Solids, Calcium, Magnesium, Copper, Hexavalent Chromium, Manganese, Sulphate, Nitrate, Fluoride, mercury, Cadmium, Selenium, Arsenic, Cyanide, Lead, Zinc, Aluminium, Boron, Phenolic Compounds, Detergents, Mineral Oil, Alkalinity, Silica.

Note : It is desired to also obtain probable composition of Total Solids if the TDS parameter exceeds 1000 ppm.

The bacteriological / Microbiological Test Parameter shall be as follows :-

MPN Coliform Organism, Coliform Bacteria, E. Coli (Typical Faecal Organism).

The above tests shall be carried out by the contractor prior to submitting the technical submittal of the water treatment plant equipment. Contractor shall also submit the test report of raw water & treated water after the commissioning of the plant. The cost of the tests (one pre equipment & two post equipment installation / commissioning) is deemed to be included in the quote.

SECTION - 8 :: FIRE PROTECTION SYSTEM

1. SCOPE

The scope of this section consists of but is not necessarily limited to supply, installation, testing and commissioning of the fire protection system. The philosophy of the system is as follows :

a. The Fire Suppression System shall comprise the Fire Hydrants System, the Sprinkler System (Wet type), Hand Appliances.

b. Water from the underground 2 nos RCC Fire Water Storage Tanks, each of 50 cum capacity, shall be supplied for the uses listed below.

i. Fire Hydrant System (Pressurised) both for the external hydrants, the internal landing valves and the hose reels at landings.

ii. Sprinkler System (Wet Type)

c. The Hydrant System and the Sprinkler System, under normal conditions, shall be lowest pressurized by means of the electric motor driven Jockey Pump.

d. The Hydrant System shall be provided with two pump sets, one of which will be diesel engine driven and the other electric motor driven.

e. The Sprinkler System shall be provided with an electric motor driven pump set.

f. The piping and valve connections shall be done so that the water from the discharge of the Hydrant Pump sets is able to supply water, automatically to the Sprinkler System whenever, the Sprinkler Pump is unable to maintain the pressure or fails and not vice versa.

g. The starting and stopping of the Jockey pump shall be automatic based on the pressure switches at preset low and high pressure.

h. The electric motor driven Hydrant Pump starts automatically at a preset pressure by means of a pressure switch. As soon as the Hydrant Pump starts, the Jockey Pump Stops. If for any reason the electric motor driven Hydrant Pump does not start at the preset pressure or is unable to maintain the pressure, the diesel engine driven Hydrant Pump starts at the preset pressure.

i. The Hydrant Pump, whether electric motor driven or the diesel engine driven shall be stopped only manually.

j. The Sprinkler Pump shall be started automatically at a preset pressure but shall be stopped only manually.

k. Contractor shall ensure that all false ceiling voids greater than 800 mm are provided with sprinklers.

l. Contractor shall ensure Hydro Testing for the complete system.

m. The Contractor shall obtain the necessary approval of the drawings and the schemes from the local authority / TAC as called for. The contractor shall also take care of any other requirement so that insurance cover can be obtained, if required at minimum premium at a later date.

n. The contractor shall design and after approval of Project Manager display near each staircase landing at floor levels, a glass covered framed floor plan clearly showing the locations of all landing valves, hose reels, hand appliances, as well as the DO's and DON'T's for the personnel and the exit direction in case of an emergency. The dimensions of the floor plan, its scale, lettering size, colour scheme etc shall be as directed by the Project Manager.

2. PIPE WORK

2.1 General Requirements

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

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

Pipes shall be securely fixed to walls and ceilings by suitable clamps and supports (galvanised after fabrication) at intervals specified. Only approved type of anchor fasteners shall be used for RCC slabs and walls / floors etc.

Valves and other appurtenances shall be so located that they are easily accessible for operations, repairs and maintenance.

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

Pipe accessories such as gauges, meters, control devices, etc. shall have the same working pressure rating as the associated pipe work. All pipe work shall be free from burrs, rust and scale and shall be cleaned before installation. All personnel engaged on welding operations must possess a certificate of competence issued by an acceptable / recognized authority.

2.2 Piping

Pipes of following types are to be used:

Mild steel black pipes as per IS:1239 heavy grade(for pipes of sizes 150 mm N.B. and below) suitably lagged on the outside to prevent soil corrosion. M.S. pipes buried below ground shall also be suitably be lagged with 2 layers of 400 micron polythene sheet over 2 coats of bitumen.

Steel pipelines upto 150 mm dia shall be as per IS: 1239, Part-II (heavy grade) while pipelines above 150 mm dia shall be as per I.S.:3589.

All pipe clamps and supports shall be fabricated from MS steel sections and shall be factory galvanised before use at site. Welding of galvanised clamps and supports shall not be permitted.

Pipes shall be hung by means of expandable anchor fastener of approved make and design. The hangers and clamps shall be fastened by means of galvanised nuts and bolts. The size/diameter of the anchor fastener and the clamps shall be suitable to carry the weight of water filled pipe and dead load normally encountered.

Hangers and supports shall be thoroughly galvanised after fabrication. The selection and design of the hanger & support shall be capable of carrying the sum of all concurrently acting loads. They shall be designed to provide the required supporting effects and allow pipeline movements as necessary. All guides, anchor braces, dampener, expansion joint and structural steel to be attached to the building/structure trenches etc. shall be provided. Hangers and components for all piping shall be approved by the Consultants.

The piping system shall be tested for leakages at 2 times the operating pressure or 1.5 time shut-off pressure, which ever is highest including testing for water hammer effects.

Flanged joints shall be used for connections for vessels, equipment, flanged valves and also on two straight lengths of pipelines of strategic points to facilitate erection and subsequent maintenance work.

For pipes under ground installation the pipes shall be buried at least one meter below ground level and shall have 230 mm x 230 mm masonry or concrete supports at least 300 mm high at 3m intervals. Masonry work to have plain cement concrete foundation (1 cement: 4 coarse sand : 8 stone aggregate) of size 380x380x75 thick resting on firm soil.

Mains below ground level shall be supported at regular intervals not exceeding 3.0 metres and shall be laid at least 2.0 metre away from the building.

2.3 Piping Installation & Support

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

Piping shall be properly supported on , or suspended from , on stands, clamps, hangers as specified and as required. The Contractor shall adequately design all the brackets, saddles, anchor, clamps and hangers, and be responsible for their structural stability.

Pipe work and fittings shall be supported by hangers or brackets so as to permit free expansion and contraction. Risers shall be supported at each floor with Galvanised steel clamps. To permit free movement of common piping support shall be from a common hanger bar fabricated from Galvanised steel sections.

Pipe hangers shall be provided at the following maximum spacings:

Pipe Dia (mm)	**Hanger Rod Dia (mm)**	**Spacing between Supports (m)**
Up to 25	6	2
32 to 50	6	2.5
65 to 80	8	2.5
80 to 100	10	2.5
125 to 150	10	3.0
200 to 300	12	3.5

The end of the steel rods shall be threaded and not welded to the threaded bolt.

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

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

Pipe sleeves, larger diameter than pipes, shall be provided wherever pipes pass through walls and slab and annular space filled with fibreglass and finished with retainer rings.

The contractor shall make sure that the clamps, brackets, saddles and hangers provided for pipe supports are adequate or as specified / approved by Consultants. Piping layout shall take due care for expansion and contraction in pipes and include expansion joints where required.

All pipes shall be accurately cut to the required sizes in accordance with relevant BIS codes and burrs removed before laying. Open ends of the piping shall be closed as the

pipe is installed to avoid entrance of foreign matter. Where reducers are to be made in horizontal runs, eccentric reduces shall be used for the piping to drain freely. In other locations, concentric reduces may be used.

Automatic air valves shall be provided at all high points in the piping system for venting. All valves shall be of 15mm pipe size and shall be associated with an equal size gate valves. Automatic air valves shall be provided on hot water risers.
Discharge from the air valves shall be piped through a pipe to the nearest drain or sump. All pipes shall be pitched towards drain points.

Pressure gauges shall be provided as shown on the approved drawings. Care shall be taken to protect pressure gauges during pressure testing.

2.4 Pipe Fittings

Pipe fittings mean tees, elbows, couplings, unions, flanges, reducers etc and all such connecting devices that are needed to complete the piping work in its totality.

Ductile Iron / Cast Iron / Forged steel screwed type fitting shall be used for pipes of 50 mm dia & below.

Fabricated fittings shall not be permitted for pipes diameters 50mm and below.

Fabricated fittings used on pipe size 65 mm & above shall be fabricated , welded in workshops. They shall be inspected by Project Manager before dispatch from the workshop. The welding procedures of the workshop should have been approved by the rules for sprinkler system and applicable to hydrant and sprinkler system. For “T” connection, pipes shall be drilled and reamed. Cutting by gas or electrical welding shall not be permitted.

2.5 Procedure For Pypkote / Coatek Application

a. Surface Preparation - The pipe surface shall be cleaned by a wire brush.

b. Application of Primer - Pypkote / Coatek primer is to be applied on pipes immediately after cleaning. This is to prevent any further accumulation of rust on the pipe. This is a cold applied primer and is applied by brush.

c. Application of Pypkote / Coatek 4 mm Tape - After the primer is applied on the pipe, it is allowed to dry for about 30 min. till it becomes touch dry. Before adhering the tape to the pipe, it is advisable to gently heat the primer coated pipe by a run of LPG torch. Remove the bottom polyethylene from the tape & then heat bottom surface of the tape by LPG torch or any heat source & start wrapping the tape to the pipe by heating the primer coated pipe & by removing the bottom polyethylene from the tape before wrapping better adhesion between the tape & pipe is obtained. Overlaps are maintained with a minimum of 12.5 mm.

d. Tape coating of weld joints - The tape is applied over the weld joints after the necessary welding & testing methods of the joints is completed. The procedure for application of tape shall be the same as bare pipe procedure. Overlaps on each side of the weld joints shall be 50 mm.

e. A final coat of White wash with water based cement paint is done immediately over the entire coated pipe.

2.6 **Jointing**

2.6.1 Welded Joints

Joints between MS pipes and fittings shall be made with the pipes and fittings having "V" groove and welded with electrical resistance welding in an approved manner. But welding without "V" groove shall not be permitted.

All joints in the pipe line with screwed fittings shall be seal welded after testing and the weld plus the adjoining portion shall be given two coats of zinc rich primer.

2.6.2 Flanged joints (65 mm dia and above)

Flanged joints with flanges conforming to IS: 6392 shall be provided on

i. Straight runs at intervals not exceeding 25-30m on pipe lines of 50 mm dia and above and as directed by the Project Manager.

j. For jointing all types of valves, appurtenances, pumps, connections with other type of pipes, to water tanks and other places necessary and as required for good engineering practice and as shown/noted on the drawings.

k. Flanges shall be with GI bolts and nuts and 3mm insertion gasket of natural rubber conforming to IS: 11149.

2.6.3 Unions (upto 50 mm dia)

Approved type of dismountable unions shall be provided on pipe lines of 40 mm dia and smaller dia, in locations similar to those specified for flanges.

3. AIR VESSEL

The air vessel shall be provided to compensate for slight loss of pressure in the system and to provide an air cushion for counter-acting pressure, surges, whenever the pumping sets come into operation. Air vessel shall conform to IS:3844. It shall be normally half full of water, when the system is in normal operation. Air vessel shall be fabricated with 8 mm thick M.S. plate with dished ends and suitable supporting legs. It shall be provided with one 100 mm dia flanged connection from pump, one 25 mm drain with valve, one water level gauge and 25 mm sockets for pressure switches. The air vessel shall be tested to pressure for 12 hours at 2 times the operating pressure or 1.5 times the shut-off.

4. AIR CUSHION TANK

Every wet riser shall be provided with an air cushion tank at its top most point. The air cushion shall be provided with an automatic air release cock, 20 mm dia drain pipe, drain valve and shut off valve.

5. FIRE BRIGADE CONNECTION

The storage tank shall be provided with a 150 mm fire brigade pumping connection to discharge at least 2275 litres / minute into it. This connection shall not be taken directly into the side of the storage tank, but arranged to discharge not less than 150 mm above the top edge of the tank such that the water flow can be seen. The connection shall be fitted with stop valve in a position approved by the Project Manager. An overflow connection discharging to a drain point shall be provided from the storage tank.

The fire brigade connection shall be fitted with four numbers of 63mm instantaneous inlets in a glass fronted wall box at a suitable position at street level, so located as to make the inlets accessible from the outside of the building. The size of the wall box shall be adequate to allow hose to be connected to the inlets, even if the door cannot be opened and the glass has to be broken. Each box shall have fall of 25mm towards the front at its base and shall be glassed with wired glass with ”FIRE BRIGADE INLET” painted on the inner face of the glass in 50 mm size block letter. Each such box shall be provided with a steel hammer with chain for breaking the glass.

In addition to the emergency fire brigade connection to the storage tank, a 150mm common connection shall be taken from the four 63mm instantaneous inlets direct to hydrant main so that the fire brigade may pump to the hydrants in the even of the hydrant pumps being out of commission. The connection shall be fitted with a sluice valve and reflux valve. Location of these valve shall be as per the approval of the Project Manager.

Two way collecting head with two numbers 63 mm instantaneous type inlets shall be connected to the sprinkler header. All other details shall be as described above.

6. SYSTEM DRAINAGE

The system shall be provided with suitable drainage arrangement with drain valves complete with all accessories.

7. VALVE CHAMBERS

Provision of suitable brick masonry chambers in cement mortar 1:5 (1 cement : 5 coarse sand) on cement concrete foundations 150 mm thick 1:5:10 mix (1 cement:5 fine sand : 10 graded stone aggregate 20 mm nominal size) with 15 mm thick cement plaster inside and outside finished with a plaster inside and outside finished with a floated coat of neat cement inside with cast iron surface box approved by fire brigade including excavation, back-filling complete shall be made.

8. VALVES

8.1 **Sluice Valves**

Sluice valves shall be double flanged valves with cast iron body. The spindle, wall seat and wedge nuts shall be of bronze. They shall generally have non-rising spindle and shall be of the particular duty and design called for.

The valves shall be supplied with suitable flanges, non- corrosive bolts and asbestos fibre gaskets. Sluice valves shall conform to Indian Standard IS : 780-1969 and IS : 2906 .

8.2 **Butterfly Valve**

The butterfly valve shall be suitable for waterworks and rated for 300 P.S.I

The body shall be of cast iron to IS:210 in circular shape and of high strength to take the water pressure . The disc shall be heavy duty cast iron with anti corrosive epoxy or nickel coating.

The valve seat shall be of high grade elastomer or nitrile rubber. The valve is closed position shall have complete contact between the seat and the disc throughout the perimeter. The elastomer rubber shall have a long life and shall not give away on continuous applied water pressure . The shaft shall be EN 8 grade carbon steel.

The valve shall be fitted between two flanges on either side of pipe flanges. The valve edge rubber shall be projected outside such that they are wedged within the pipe flanges to prevent leakages.

8.3 **Ball Valve**

The ball valve shall be made forged brass and suitable for test pressure of pipe line. The valve shall be internally threaded to receive pipe connections.

The ball shall be made from brass and machined to perfect round shape and subsequently chrome plated. The seat of the valve body-bonnet gasket and gland packing shall be of Teflon.

The handle shall be provided with PVC jacket. The handle shall also indicate the direction of ‘open’ and ‘closed’ situations. The gap between the ball and the teflon packing shall be sealed to prevent water seeping.

The handle shall also be provided with a lug to keep the movement of the ball valve within 90°. The lever shall be operated smoothly and without application of any unnecessary force.

8.4 **Gun Metal Valves**

Gun metal Valves shall be used for smaller dia pipes, and for threaded connections. The Valves shall bear certification as per IS: 778

The body and bonnet shall be of gun metal to IS:318. The stem gland and gland nut shall be of forged brass to IS: 6912. The hand wheel shall be of cast iron to IS:210.

The Hand wheel shall be of high quality finish to avoid hand abrasions. Movement shall also be easy. The spindle shall be non rising type.

8.5 **Non-Return Valve**

Non-Return valves shall be cast iron double flanged with cast iron body and gunmetal internal parts conforming to IS: 5312.

8.6 **Pressure Relief Valve**

Each System shall be provided with a Pressure Relief Valves. The Valve shall be spring actuated and set to operate as per field requirement. The Valve shall be constructed of bronze and provided with an open discharge orifice for releasing the water. The Valve shall be open lift type.

9. PRESSURE SWITCH

The pressure switches shall be employed for starting and shutting down operation of pumps automatically, dictated by line pressure. The Pressure Switch shall be diaphragm type. The housing shall be die cast aluminium, with SS 316 movement, pressure element and socket. The set pressure shall be adjustable.

The Switch shall be suitable for consistent and repeated operations without change in values. It shall be provided with IP:55 water and environment protection.

10. PRESSURE GAUGE

Pressure gauge shall be provided near all individual connections of the hydrant system with isolation valves and near each flow switch assembly of the sprinkler system. Pressure gauge shall be 50 mm dia gunmetal bourdon type with gunmetal isolation ball valve, tapping and connecting pipe and nipple. The gauge shall be installed at appropriate height for easy readability.

11. PAINTING

All Hydrant and Sprinkler pipes shall be painted with post office red colour paint. All M S pipes shall first be cleaned thoroughly before application of primer coat. After application of primer coat two coats of enamel paint shall be applied. Each coat shall be given minimum 24 hours drying time. No thinners shall be used. Wherever required all pipe headers shall be worded indicating the direction of the pipe and its purpose such as "TO RISER NO.1" etc.

Painting shall be expertly applied, the paint shall not over run on surfaces not requiring painting such as walls, surfaces etc. Nuts and bolts shall be painted black, while valves shall be painted blue.

12. EXCAVATION

Excavation for pipe lines shall be in open trenches to levels and grades shown on the drawings or as required at site. Pipe lines shall be burried with a minimum cover of 1 meter or as shown on drawings.

Wherever required Contractor shall support all trenches or adjoining structures with adequate timber supports, shoring and strutting.

On completion of testing in the presence of the Project Manager and pipe protection, trenches shall be backfilled in 150 mm layers and consolidated.

Contractor shall dispose off all surplus earth as directed by the Project Manager.

13. ANCHOR / THRUST BLOCK

Contractor shall provide suitably designed anchor blocks in cement concrete/steel support to cater to the excess thrust due to work hammer and high pressure

Thrust blocks shall be provided at all bends, tees and such other location as determined by the Project Manager.

Exact location, design, size and mix of the concrete blocks/steel support shall be as shown on the drawings or as directed by the Project Manager prior to execution of work.

14. FIRE HYDRANTS

14.1 **External Hydrants**

a. Contractor shall provide external hydrants. The hydrants shall be controlled by a cast iron sluice valve. Hydrants shall have instantaneous type 63mm dia outlets. The hydrants shall be single outlet conforming to IS: 908 with CI duck foot bend and flanged riser or required height to bring the hydrant to correct level above ground.

b. Contractor shall provide for each external fire hydrant two numbers of 63mm dia. 15 m long controlled percolation hose pipe with SS male and female instantaneous type couplings machine wound with GI wire (hose to IS:636 type certification) , SS branch pipe with nozzle to IS:903. This shall be measured and paid for separately.

c. Each external hydrant hose cabinet shall be provided with a drain in the bottom plate.

d. Each external hydrant hose cabinet containing items as above shall also be provided with a nozzle spanner and a Fireman's Axe. This shall be measured and paid for separately.

e. Each hose cabinet shall be conspicuously painted with the letters "FIRE HOSE".

14.2 **Internal Hydrants**

a. Contractor shall provide on each landing and other locations as shown on the drawings double headed SS landing valve with 100 mm dia inlet as per IS:5290, with shut off valves having cast iron wheels as shown on the drawings. Landing valve shall have flanged inlet and instantaneous type outlets as shown on the drawings.

b. Instantaneous outlets for fire hydrants shall be standard pattern and suitable for fire hoses.

c. Contractor shall provide for each internal fire hydrant station two numbers of 63 mm dia. 15 m long rubberized fabric lined hose pipes with SS male and female instantaneous type coupling machine would with GI wire (hose to IS:636 type 2 and couplings to IS:903 with IS certification), fire hose reel, SS branch pipe with nozzle to IS:903. This shall be measured and paid for separately.

d. Contractor shall provide standard fire hose reels of 20mm dia high pressure dunlop rubber hose 36 m long with gunmetal nozzle, all mounted on a circular hose reel of heavy duty mild steel construction having cast iron brackets. Hose reel shall be connected directly to the wet riser with an isolating valve. Hose reel shall conform to IS:884 and shall be mounted vertically . This shall be measured and paid for separately.

e. Each internal hydrant hose cabinet shall be provided with a drain in the bottom plate. The drain point shall be lead away to the nearest general drain.

f. Each internal hydrant hose cabinet containing items as above shall also be provided with a nozzle spanner and a Fireman's Axe. The cabinet shall be recessed in the wall as directed. This shall be measured and paid for separately.

g. Each hose cabinet shall be conspicuously painted with the letters "FIRE HOSE".

14.3 **Hose Reel**

Hose reel shall conform to IS : 884, heavy duty, 20 mm dia length shall be 36 metre long fitted with gun metal chromium plated nozzle, mild steel pressed reel drum which can swing upto 170 degree with wall brackets of cast iron finished with red and black enamel complete.

14.4 **Fire Hose**

All hose pipes shall be of 63 mm diameter RRL/ CP as required, conforming to IS : 636 or IS : 8423. The hose shall be provided with copper alloy delivery coupling. The hose shall be capable of withstanding a bursting pressure of 35.7 Kg/Sq.cm without undue leakage or sweating. Hose shall be provided with instantaneous spring-lock, type couplings.

14.5 **Branch Pipe, Nozzle**

Branch pipes shall be of SS with loaded tin bronze ring at the discharge and to receive the nozzle and provided at the other with a leaded tin bronze ring to fit into the instantaneous coupling. Nozzle shall be of spray type of diameter of not less than 16 mm and not more than 25 mm. Nozzle shall be of loaded tin bronze branch pipe and nozzle shall be of instantaneous pattern conforming to Indian Standard - 903.

14.6 **Hose Cabinet**

Hose cabinet shall be provided for all internal and external fire hydrants. Hose cabinets shall be fabricated from 16 gauge SS powder coated sheet of fully welded construction with hinged double front door partially glazed (3 mm glass panel) with locking arrangement, stove enamelled fire red paint (shade No. 536 of IS:5) with "FIRE HOSE" written on it prominently (size as given in the schedule of quantities). Cabinet surfaces in contact with the walls shall not be powder coated but instead given two coats of anti-corrosive bitumastic paint.

14.7 **Internal Hose Cabinet**

Hose cabinet shall be of glass fronted with hinged door & lock. The cabinet shall be made of 16 gauge thick SS sheet and spray painted to shade No. 536 of IS:5. The hose cabinet shall be of size to accommodate the following:

i. Landing Valves (Single headed)
ii. Hose pipe
iii. Hose reel (36.5 mtr.)
iv. Branch pipes, nozzles (1 sets)
v. Fire man's axe and hand appliances

14.8 External Hose Cabinet

The hose cabinet shall be of size to accommodate the following:

i. Single/Double headed yard hydrant valve
ii. Hose pipe (2 length of 15 m)
iii. Branch pipes, nozzles (1 sets)
iv. Fire man's axe

15. SPRINKLER SYSTEM

15.1 General Specification

The scope of work shall include supply, commissioning, testing of the system as a whole. The sprinkler heads are to be fixed into heavy quality black steel pipes, conforming to IS 1239 or any other approved specification. The size of pipe will vary from 20 mm to 150mm to suit the hydraulics of the system. The System shall conform to CFO Rules for the installation of sprinkler systems in general for 'Ordinary Hazard' category-in respect of design, density and spacing of sprinkler heads.

Reduction in pipe sizes shall not be made by use of bushings. All piping shall be done by means of welding, screwed & flanged jointing as per codes.

Due care shall be taken that sprinklers are not applied with paint at the time of applying paint to piping and fittings.

All control, drain, test and alarm valves shall be provided with signs to identify their purposes, functions, direction of flow the satisfaction of the Consultants.

15.2 Quartzoid Bulb Automatic Sprinkler

Sprinkler heads shall be made of brass/quartzoid bulb sufficiently strong, in compression to withstand any pressure, surge or hammer likely to occur in the system. The yoke & body shall be made of high quality gun metal brass with arms streamlined to ensure minimum interference with the spread of water. The deflector of suitable design shall be fitted to give even distribution of water over the area commanded by the sprinkler.

The bulb shall contain a liquid having a freezing point below any natural climatic figure and a high coefficient of expansion. The temperature rating of the sprinkler shall be stamped on the deflector & the colour of the liquid filled in the bulb shall be according to the temperature rating as per HFPA standard. The sprinkler heads shall be of type & quality approved by the local fire brigade authority. The inlet shall be screwed.

The sprinklers shall have 15mm nominal size of the orifice for ordinary hazard.

The orifice size shall be marked on the body or the deflector of the sprinkler.

Metal guards for protection of sprinkler against accidental or mechanical damage shall be provided as desired by the Project Manager.

Contractor shall submit detailed submittal and discharge spray pattern for the Sprinkler for the approval of consultant.

15.2.1 Operating Temperature

The Operating temperature, at which the quartzoid bulb of the sprinkler head shall actuate, shall be 68 degree C or as specifically mentioned.

15.2.2 Sprinkler Installation

Sprinkler heads shall be located in positions shown on the drawings. While slight relocation may result from building construction features or interference from other services, the maximum spacing between sprinkler heads and coverage area shall not exceed those stipulated in the TAC regulations and the NFPA 13-1994 Rules.

Allowance shall be made for such relocations within a radius of 1500 mm of the indicated positions without additional cost. The Fire Protection Services Trade shall co-ordinate with the ceiling Trade to set out the sprinkler locations to suit the site location of the unit grid. In general, all sprinklers shall be located at the centre of the ceiling unit and a provision of about 10% more sprinklers and pipe work than required in TAC and NFPA Rules shall be included in this sub-contract. Chrome plated wire mesh guards shall be used to protect the sprinkler heads which are liable to accidental or mechanical (at no extra cost) damage.

15.3 **Flow Requirements**

The flow requirement for sprinkler heads shall be specifically approved for the designated area of installation.

15.4 **Orifice Plates**

For restricting pressure at lower levels in the sprinkler system, orifice plates of appropriate sizes shall be fitted at different floor levels, at the branching points from Riser Main.

The Diameter of such orifice shall not be less than 50% of the dia of pipe into which it is to be fitted, which shall not be less than 50mm dia. These orifice plates must be of stainless steel with plain central hole without burrs, and the thickness shall be 3mm for pipe size upto 80 mm, 6 mm for pipes from 80 to 125 mm dia and 9 mm for pipes greater than 125 mm dia. Such orifice plate must have a projecting identification tag.

The orifice plate shall fitted not less than two pipe internal diameters down stream of the outlet from any elbow or brand.

Contractor shall submit the design and identify location on drawing before installation.

15.5 **Installation Control Valves**

Each installation shall be provided with a set of installation control valves comprising:-

a. An Alarm Valve.

b. A Water Motor Alarm & Gong.

c. Installation valves shall be installed on the sprinkler circuits as shown on the drawings.

d. Contractor shall submit detailed shop drawings showing the exact location, details of installation of the valves/alarm in all respects.

e. Installation valve shall comprise of a cast iron body with gunmetal trim, and double seated clapper check valves, pressure gauges, test valve and orifice assembly and drain valve with pressure gauges, turbine water gong including all accessories necessary and required and as supplied by original equipment manufacturer and required for full and satisfactory performance of the system. A cast iron isolation valve with lock and chain at the inlet of the installation valve shall be provided.

15.6 **Inspection And Test Valve Assembly**

Inspection and testing of the automatic starting of the sprinkler system shall be done by providing an assembly consisting of gunmetal valves, gunmetal sight glass, bye-pass valve and orifice assembly as per approved drawing.

15.7 **Flow Switch**

Flow switch shall have a paddle made of flexible and sturdy material of the width to fit within the pipe bore. The terminal box shall be mounted over the paddle/ pipe through a connecting socket. The Switch shall be potential free in either N O or N C position as required. The switch shall be able to trip and make / break contact on the operation of a single sprinkler head. The terminal box shall have connections for wiring to the Annunciation Panel. The flow switch shall have connections for wiring the seat shall be of S.S to the Annunciation Panel. The flow switch shall have IP: 55 protection.

The flow switch work at a triggering threshold bandwidth (flow rate) of 4 to 10 GPM. Further, it shall have a ‘Retard’ to compensate for line leakage or intermitted flows.

15.8 **The Main Stop Valve**

These shall be of cast iron body of requisite size. When closed, these will shut off supply of water to the installation.

A location plate must be fixed on the outside or an external wall, as near to the main stop valve as possible, bearing the following words on raised letters or other approved type letter.

i **Sprinkler Stop Valve Inside :** The word `sprinkler stop valve' shall be in letters of at least 35mm and the word "INSIDE" at least25mm in height. The words shall be painted white on black back ground.

ii All stop valves shall be right handed i.e. they shall be so constructed that in order to shut the valve the spindle shall turn from left to right. There shall be an indicator which will show whether the valve is open or shut.

15.9 **Pipes For Drainage**

Sprinkler pipes shall be so installed that the system can be thoroughly drained. As far as possible all pipes shall be arranged to drain to the installation drain valve as shown in the drawing for ordinary hazard system.

In the case of basement & other areas where sprinkler pipe-work is below the installation drain valve & in other trapped points in the system, auxiliary valves of the following sizes shall be provided.

-20 mm valves for pipes upto 50mm dia.
-25 mm valves for 80mm dia pipe.
-50 mm valves for pipes larger than 80mm dia.

15.10 **System Design**

The entire sprinkler installation shall be designed to make it a hydraulically balanced system. The pressure requirement at typical floors shall be designed between 2.5 bar and 3.5 bar.

16. HAND HELD FIRE EXTINGUISHERS

16.1 **Hand Appliances**

16.1.1 Scope

Work under this section shall consist of furnishing all labour, materials, appliances and equipment necessary and required to install fire extinguishing hand appliances as per relevant specification of various authorities.

Without restricting to the generality of the foregoing, the work shall consists of the following:

Installation of fully charged and tested fire extinguishing hand appliances of A B C powder type as required and specified in the drawings and schedule of rates.

16.2 **General Requirements**

Hand appliances shall be installed in easily accessible locations with the brackets fixed to the wall by suitable anchor fasteners.

Each appliance shall be provided with an inspection card indicating the date of inspection, testing, change of charge and other relevant data.

All appliances shall be fixed in a true workmanlike manner truly vertical and at correct locations.

Distribution / installation of fire extinguisher to be in accordance to IS:2190.

16.3 **Measurement**

Fire extinguishers shall be counted in numbers and include installation of all necessary items required as given in the specifications.

16.4 **ABC Type Dry Powder Extinguisher**

The Extinguisher shall be filled with ABC grade 40, Mono Ammonium Phosphate 40% from any approved manufacturer.

The capacity of the extinguisher when filled with Dry Chemical Powder (First filling) as per IS 4308, Part II, shall be 5 Kg +/-2% or 10 Kg +/- 3%.

The distribution of fire extinguishers to be as per IS 2190 – 1992.

It shall be operated upright, with a squeeze grip valve to control discharge. The plunger neck shall have a safety clip, fitted with a pin, to prevent accidental discharge. It shall be pressurised with Dry Nitrogen, as expellant. The Nitrogen to be charged at a pressure of 15 Kg/cm2

Body shall be of mild steel conforming to relevant IS Standards. The neck ring shall be also mild steel and welded to the body. The discharge valve body, shall be forged brass or leaded bronze, while the spindle, spring and siphon tube shall be of brass. The nozzle shall be of brass, while the hose shall be braided nylon. The body shall be cylindrical in shape, with the dish and dome welded to it. Sufficient space for Nitrogen gas shall be provided inside the body, above the powder filling.

The Neck Ring shall be externally threaded - the threading portion being 1.6 cm. The filler opening in the neck ring shall not less than 50 mm. Discharge nozzle shall be screwed to the hose. The design of the nozzle shall meet the performance requirement, so as to discharge at least 85% of contents upto a throw of 4 mtrs, continuously, at least for 15 seconds. The hose, forming part of discharge nozzle, shall be 500 mm long, with 10 mm dia internally for 5 Kg capacity and 12 mm for 10 Kg capacity. It shall have a pressure gauge fitted to the valve assembly or the cylinder to indicate pressure available inside. The extinguisher shall be treated with anti-corrosive paint, and it shall be labelled with words ABC 2.5 cm long, within a triangle of 5 cm on each face. The extinguisher body and valve assembly shall withstand internal pressure of 30 Kg/cm^2 for a minimum period of 2 minutes. The pressure gauge shall be imported and suited for the purpose.

16.5 **Water Type Extinguisher (Gas Pressure Type)**

The Extinguishing medium shall be primarily water stored under normal pressure, the discharge being affected by release of Carbon Dioxide Gas from a 120 gms cylinder.

The capacity of Extinguisher, when filled upto the indicated level, shall be 9 ltr +/- 5%

The skin thickness of the Cylinder shall be minimum 4.0 mm, fabricated from Mild Steel sheet, welded as required, with dish and dome, being of same thickness, and of size not exceeding the diameter of body. The diameter of body to be not less than 150 mm and not exceeding 200 mm. The neck shall be externally threaded upto a minimum depth of 16 mm, and leaded tin bronze.

The cap shall be of leaded tin bronze, and screwed on the body upto a minimum of 1.6 cm depth, with parallel screw thread to match the neck ring. The siphon tube to be of brass or G.I. and the strainer of Brass. The cartridge holder, knob, discharge fittings and plunger to be of Brass/Leaded tin bronze, and plunger of stainless steel, spring of stainless steel. The cap to have handle fixed to it. The discharge hose shall be braided nylon, of 10 mm dia and 600 mm long, with a nozzle of brass fitted at end.

The extinguisher shall be treated for anti-corrosion internally and externally, and externally painted with Fire Red paint. The paint shall be stove enamelled/powder coated. The cartridge shall be as per IS, and have 60 gm net carbon dioxide gas for expelling. The extinguisher, body and cap shall be treated to an internal hydraulic pressure of 25 Kg/cm2. It shall have external marking with letter A, of 2.5 cm height, in block letters within a triangle of 5 cm each side. The extinguisher shall be upright in operation, with the body placed on ground and discharge tube with nozzle held in one hand to give a throw of not less than 6 mtr, and continue so for atleast 60 secs. The extinguisher body shall be clearly marked with ISI stamp (IS 940).

16.6 **Carbon Dioxide Extinguisher**

The Carbon Dioxide Extinguisher shall be as per IS: 2878

The body shall be constructed of seamless tube conforming to IS: 7285 and having a convex dome and flat base. Its dia shall be maximum 140 mm, and the overall height shall not exceed 720 mm.

The discharge mechanism shall be through a control valve conforming to IS: 3224. The internal syphon tube shall be of copper aluminium conforming to relevant specifications.

Hose Pipe shall be high pressure braided Rubber hose with a minimum burst pressure of 140 Kg/cm2 and shall be approximately 1.0 meter in length having internal dia of 10 mm. The discharge horn shall be of high quality unbreakable plastic with gradually expanding shape, to convert liquid carbon dioxide into gas form. The hand grip of Discharge horn shall be insulated with Rubber of appropriate thickness.

The gas shall be conforming to IS: 307 and shall be stored at about 85 Kg/cm2. The expansion ratio between stored liquid carbon dioxide to expanded gas shall be 1:9 times and the total discharge time (effective) shall be minimum 10 secs and maximum 25 secs.

The extinguisher shall fulfill the following test pressures:
Cylinder: 236 Kg/cm2
Control Valve: 125 Kg/cm2

Burst Pressure of Hose: 140 Kg/cm2 minimum

It shall be an Upright type. The cylinder, including the control valve and high pressure Discharge Hose must comply with relevant Statutory Regulations, and be approved by Chief Controller of Explosives, Nagpur and also bear IS marking.

The Extinguisher including components shall be IS marked.

17. FIRE PUMPS AND ALLIED EQUIPMENTS

17.1 Scope

Work under this section shall consist of furnishing all labour, materials, equipment and appliances necessary and required to completely install electrically operated and diesel driven pumps and as required by drawings and specified hereinafter or given in the schedule of rates.

a. Electrically operated pumps with motors and diesel engine driven pumps with diesel engine, common base plates, coupling, coupling guard and accessories.

b. Automatic starting system with all accessories, wiring and connections and pressure switches.

c. Motor control centre.

d. Annunciation system with all accessories wiring and connections.

e. Pressure gauges with isolation valves and piping, bleed and block valves.

f. Suction strainers and accessories.

g. Vibration eliminator pads and foundation bolts.

h. Leak-off drain shall be led to the nearest floor drain.

17.2 General Requirements

Pumps shall be installed true to levels on suitable concrete foundations. Base plate shall be firmly fixed by properly grouted foundation bolts.

Pumps and motors shall be truly aligned by suitably instruments. Record of such alignment shall be furnished to the Project Manager.

All pump connections shall be standard flanged type with number of bolts as per relevant standard requirement for the working pressure. Companion flanges shall be provided with the pumps.

Manufacturers' instructions regarding installation, connections and commissioning shall be strictly followed.

Contractor shall provide necessary test certificates, type test certificates, performance curves and NPSH curves of the pumps from the manufacturer when called for. The contractor shall provide facilities to the Project Manager & Consultant for inspection of equipment during manufacturing and also to witness various tests at the manufacturer's works without any cost to the Project Manager or Consultant.

Seismic isolation and clamping for each pump and flexible connection on the suction as well as the discharge side shall be provided.

The contractor shall submit with this tender a list of recommended spare parts for three years of normal operation and quote the prices for the same as a separate submittal / annexure.

17.3 **Electric Fire Pump**

General

The electric fire pump shall be suitable for automatic operation complete with necessary electric motor and automatic starting gear, suitable for operation on 415 volts, 3 phase, 50 Hz. A.C. system. Both the motor and the pump shall be assembled on a common base plate, fabricated M.S. channel type or cast iron type.

Drive

The pump shall be direct driven by means of a flexible coupling. Coupling guard shall also be provided.

17.4 **Fire Pump**

The fire pump shall be horizontally mounted multistage centrifugal type. It shall have a capacity to deliver 2850 lpm as specified, and developing adequate head so as to ensure a minimum pressure of 3.5 Kg/Sq.cm at the highest and the farthest outlet.

The pump shall be capable of giving a discharge of not less than 150 per cent of the rated discharge, at a head of not less than 65 per cent of the rated head. The shut off head shall be within 120 per cent of the rated head.

The pump casing shall be of cast iron to grade FG 200 to IS: 210 and parts like impeller, shaft sleeve, wearing ring etc. shall be of non-corrosive metal like bronze/brass/gun metal. The shaft shall be of stainless steel. Provision of mechanical seal shall also be made.

Bearings of the pump shall be effectively sealed to prevent loss of lubricant or entry of dust or water. The pump shall be provided with a plate indicating the suction lift, delivery head, discharge, speed and number of stages. The pump casing shall be designed to withstand 1.5 times the working pressure.

Provision of Jockey Pump shall be made. The pump shall be vertical SS type and of detail as in schedule of quantity. Contractor shall verify that the capacity of the Jockey pump shall not be less than 3% (Minimum 180 LPM) and not more than 10% of the installed pump capacity.

Motor

The motor shall be squirrel cage A.C. induction type suitable for operation on 415 volts 3 phase 50 Hz. system. The motor shall be totally enclosed fan cooled type conforming to protection clause IP 55. The class of insulation shall be F. The synchronous speed shall be 1500 RPM as specified. The motor shall be rated for continuous duty and shall have a horse power rating necessary to drive the pump at 150 per cent of its rated discharge with at least 65 per cent rated head. The motor shall conform to I.S.325-1978.

Motor Starter

The motor starter shall be as per detail in MCC. The unit shall include suitable current transformer and ammeter of suitable range on one line to indicate the current. The starter shall not incorporate under voltage, no voltage trip overload or SPP.

The starter assembly shall be suitably integrated in the power and control panel for the wet riser system & sprinkler system.

17.5 **Diesel Fire Pump**

General

The diesel pump set shall be suitable for automatic operation complete with necessary automatic starting gear, for starting on wet battery system and shall be complete with all accessories. Both engine and pump shall be assembled on a common base plate.

Drive

The pump shall be only direct driven by means of a flexible coupling. Coupling guard shall also be provided. The speed shall be 1500 RPM as specified.

Fire Pump

The fire pump shall be horizontally mounted centrifugal multi stage. It shall have a capacity to deliver as specified, and developing adequate head so as to ensure a minimum pressure of 3.5 Kg/Sq.cm at the highest and the farthest outlet. The pump shall be multi stage as specified. The pump shall be capable of giving a discharge of not less than 150% of the rated discharge at a head of not less than 65% of the rated head. The shut off head shall be within 120% of the rated head.

The pump casing shall be of cast iron to grade FG 200 to IS 210 and parts like impeller, shaft sleeves, wearing-ring etc. shall be of non-corrosive metal like bronze/brass/gun metal. The shaft shall be stainless steel. Provision of mechanical seal shall also be made.

The pump casing shall be designed to withstand 1.5 times the working pressure.

Bearing of pump shall be effectively sealed to prevent loss of lubricant or entry of dust or water.

Diesel Engine

Engine Rating - The engine shall be cold starting type without the necessity of preliminary heating of the engine cylinders or combustion chamber (for example, by wicks, cartridge, heater, plugs etc.). The engine shall be multi cylinder/vertical 4 stroke cycle, aircooled, diesel engine, developing suitable HP at the operating speed specified to drive the fire pump. Continuous capacity available for the load shall be exclusive of the power requirement of auxiliaries of the diesel engine, and the after correction for altitude, ambient temperature and humidity for the specified environmental conditions. This shall be at least 20% greater than the maximum HP required to drive the pump at its duty point. It shall also be capable of driving the pump at 150% of the rated discharge at 65% of rated head. The engine shall be capable of continuous non-stop operation for 8 hours and major overhaul shall not be required before 3000 hours of operation. The engine shall have 10% overload capacity for one hour in any period of 12 hours continuous run. The

engine shall accept full load within 15 seconds from the receipt of signal to start. The diesel engine shall conform to BS 649/IS 1601/IS 10002, all amended up to date.

a. **Engine Accessories** - The engine shall be complete with the following accessories:-

Fly wheel dynamically balanced.
Direct coupling for pump and coupling guard.
Corrosion Resistor.
Air cleaner.
Fuel service tank support, and fuel oil filter with necessary pipe work.
Elect. starting battery (2X24 v).
Exhaust silencer with necessary pipe work.
Governor.

Instrument panel housing all the gauges, including Tachometer, hour meter and starting switch with key (for manual starting).

Necessary safety controls.

b. **Fuel System** - The fuel shall be gravity fed from the engine fuel tank to the engine driven fuel pump. The engine fuel tank shall be mounted either over or adjacent to the engine itself or suitably wall mounted on bracket. The fuel filter shall be suitably located to permit easy servicing.

All fuel tubing to the engine shall be with copper, with flexible hose connections where required. Plastic tubing shall not be permitted.

The fuel tank shall be of welded steel construction (3 mm. thick) and of capacity sufficient to allow the engine to run on full load for at least 8 hours. The tank shall be complete with necessary wall mounted supports, level indicator (protected against mechanical injury) inlet, outlet, overflow connections and drain plug and piping to the engine fuel tank. The outlet shall be so located as to avoid entry of any sediments into the fuel line to the engine.

As semi rotary hand pump for filling the daily service tank together with hose pipe 5 mtr. long with a foot valve etc. shall also form part of the scope of supply.

c. **Lubricating Oil System**- Forced feed Lub. Oil system shall be employed for positive lubrication. Necessary Lub. oil filters shall be provided, located suitably for convenient servicing.

d. **Starting System**- The starting system shall comprise necessary batteries (2x24v), 24 volts starter motor of adequate capacity and axle type gear to match with the toothed ring on the fly wheel. Bi metallic relay protection to protect starting motor from excessively long cranking runs suitably integrated with engine protection system shall be included within the scope of the work.

The capacity of the battery shall be suitable for meeting the needs of the starting system.

The battery capacity shall be adequate for 10 consecutive starts without recharging with cold engine under full compression.

The scope shall cover all cabling, terminals, initial charging etc.

e. **Exhaust System** - The exhaust system shall be complete with silencer suitable for outdoor installation and silencer piping including bends and accessories needed for a run of 15 metre from the engine manifold.(Adjustment rates for extra lengths shall also be given). The total back pressure shall not exceed the engine manufacture's recommendation. The exhaust piping shall be suitably supported.

f. **Engine shut down mechanism-** This shall be auto/ manually operated and shall return automatically to the starting position after use.

g. **Governing System**- The engine shall be provided with an adjustable governor to control the engine speed within 5% of its rated speed under all conditions of load up to full load. The governor shall be set to maintain rated pump speed at maximum pump load.

h. **Engine Instrumentation**- Engine instrumentation shall include the following:-

i) Lub. oil pressure gauge.
ii) Lub. oil temperature gauge.
iii)Water pressure gauge.
iv)Water temperature gauge.
v) Tachometer.
vi) Hour meter.

The instrumentation panel shall be suitably resident mounted on the engine.

Engine Protection Devices- Following engine protection and automatic shut down facilities shall be provided:-

i) Low lub.oil pressure.
ii) High cooling water temp.
iii) High lub.oil temperature.
iv) Over speed shut down.

i. **Pipe Work** - All pipe lines with fittings and accessories required shall be provided for fuel oil, lub.oil and exhaust systems, copper piping of adequate sizes, shall be used for Lub.oil and fuel oil. M.S. piping will be permitted for exhaust.

j. **Anti Vibration Mounting**- Suitable vibration mounting duly approved by Project Manager shall be employed for mounting the unit so as to minimise transmission of vibration to the structure. The isolation efficiency achievable shall be clearly indicated.

k. **Battery Charger**-Necessary float and boost charger shall be incorporated in the control section of the power and control panel, to keep the battery in trim condition. Voltmeter to indicate the state of charge of the batteries shall be provided.

17.6 **Pump Sets Assembly**

On the main fire sprinkler and hydrant headers near pump sets a 150 mm dia by-pass valve located in an accessible location shall be provided along with a rate of flow rota meter calibrated in 1 pm and able to read 200% of the rated pump capacity. The delivery shall be connected to the fire tank.

Each and every pump set assembly shall be provided with suction valve (only for positive suction head), discharge valve, non-return valve and 150 mm dia Bourdon type pressure gauge with isolation valve.

17.7 **Flexible Connectors**

On all suction and delivery lines double flanged reinforced neoprene flexible pipe connectors shall be provided. Connectors should be suitable for maximum working pressure of each pipe line on which it is mounted and tested to a test pressure of 1:5 time the operating pressure. Length of the connector shall be as per manufacturers standard.

17.8 **Interlocking**

The following inter-locking between the two main fire pumps (i.e. wet riser pump & sprinkler pump), the jockey pump and the diesel engine driven pump.

Only one category of pumps will work at a time i.e. either jockey pump or main fire pumps (wet riser and sprinkler, both the wet riser and sprinkler can come up at a time) or diesel driven pump.

	JOCKEY PUMP	WET RISER PUMP	SPRINKLER PUMP	DIESEL DRIVEN PUMP
i.	ON	OFF	OFF	OFF
ii.	OFF	ON	OFF	OFF
iii.	OFF	OFF	ON	OFF
iv.	OFF	ON	ON	OFF
v.	OFF	OFF	ON	ON
vi.	OFF	OFF	OFF	ON
vii	OFF	ON	OFF	ON

17.9 **Annunciation Panel**

One solid state electronic annunciation panel, fully wired with visual display and audible alarm unit shall be provided to indicate :

a. Flow condition in any flow switch indicating the area of distress and fire alarm.
b. Starting and stopping of each hydrant pump.
c. Starting and stopping of each jockey pump.
d. Starting and stopping of each sprinkler pump.
e. Failure of Hydrant / Sprinkler pump to start.
f. High level in fire water storage tank compartment.

g. Low level in fire water storage tank compartment.
h. Low level in HSD day tank of the fire pump.

The panel shall be factory fabricated, wired and tested. All details shall be submitted with the tender.

The annunciation panel shall be located in the security office / reception on the ground floor or as instructed by the Project Manager.

17.10 **Vibration Isolation**

The pumpset shall be mounted on rolled steel channels and 150 mm thick inertia block spring and ribbed neoprene vibration isolation mounting shall support the inertia block onto a 100 mm thick concrete plinths. The spring mountings shall have a maximum deflection of15 mm. Reference shall be made to the section on "Nose and Vibration" for further technical requirements.

SECTION - 9 :: ELECTRICAL INSTALLATION

1. SCOPE

The scope of this section comprises of fabrication, supply, erection, testing and commissioning of Motor Control Centre (MCC), wiring and earthing of all air-conditioning equipment, components and accessories.

2. GENERAL

Work shall be carried out in accordance with the accompanying specifications and shall comply with the latest relevant Indian Standards and Electricity Rules and Regulations.

All motor control centres shall be CPRI approved and shall be suitable for operation on 3 phase/single phase 415/230 volts, 50 cycles power supply system.

3. CONSTRUCTIONAL FEATURES

The Motor Control Centre (MCC) electrical panels shall be sheet steel cabinet for indoor installation, dead front, floor mounting/wall mounting type and shall be 3b construction. The control panel shall be totally enclosed, completely dust and vermin proof and shall be with hinged doors with Neoprene gasket. Control panel shall be suitable for the climatic conditions as specified in Specifications. Steel sheets used in the construction of Control panel shall be 2 mm thick and shall be folded and braced as necessary to provide a rigid support for all components. Joints of any kind in sheet metal shall be seam welded, all welding, slag shall be rounded off and welding pits wiped smooth with plumber metal. The general construction shall confirm to relevant BIS Codes.

All panels and covers shall be properly fitted and square with the frame, and holes in the panel correctly positioned. Fixing screws shall enter into holes tapped into an adequate thickness of metal or provided with wing nuts. Self threading screws shall not be used in the construction of Control panels. A base channel of 75 mm x 40 mm x 5

mm thick shall be provided at the bottom for floor mounted panels. Minimum clearance of 275 mm shall be provided between the floor of control panel and the lowest unit.

The control panel shall be of adequate size with a provision of 25% spare space to accommodate possible future breakers. Breakers shall be arranged in multi-tier. Knockout holes of appropriate size and number shall be provided in the Motor Control Centre in conformity with the location of cable/conduit connections. Removable sheet steel plates shall be provided at the top to make holes for additional cable entry at site if required.

Every cabinet shall be provided with Trifoliate or engraved metal name plates. All panels shall be provided with circuit diagram mounted on inside of door shutter protected with Hylam sheet. All live accessible connections shall be shrouded and shall be finger touch proof and minimum clearance between phase and earth shall be 20 mm and phase to phase shall be 25 mm.

4. WIRING SYSTEM

All L T power cabling between MCC and motors shall be carried out with 1100 volts grade PVC insulated, overall PVC sheathed aluminium conductor armoured cables, Cables shall be sized by applying proper derating factor. All control wiring shall be carried out by using PVC insulated copper conductor wires in conduits. Minimum size of control wiring shall be 1.5 sq mm. Minimum size of conductor for power wiring shall be 4 sq. mm 1100 volts grade PVC insulated copper conductor wires in conduit.

5. CIRCUIT COMPARTMENT

Each circuit breaker, contactor and relay shall be housed in a separate compartment and shall have steel sheets on top and bottom of compartment. Sheet steel hinged lockable door shall be duly interlocked with the breaker in the “ON” position. Safety interlocks shall be provided to prevent the breaker from being drawn-out when the breaker is in ‘ON’ position. The door shall not form an integral part of the draw-out portion of the panel. Sheet steel barriers shall be provided between the tiers in a vertical section.

6. INSTRUMENT ACCOMMODATION

Adequate space shall be provided for accommodating instruments, indicating lamps, control contactors and control MCBs. These shall be accessible for testing and maintenance without any danger of accidental contact with live parts of the circuit breaker and bus bar `ON’ lamps shall be provided on all outgoing feeders.

7. BUS BAR CONNECTIONS

Bus bar and interconnections shall be of high conductivity electrolytic aluminium complying with requirement of grade E91E of IS:5082-1981 and shall be of rectangular cross section suitable for carrying the rated full load current and short circuit current without overheating of phase and neutral bus bar and shall be extendable on either side. Bus bar and interconnections shall be insulated with heat shrinkable sleeve and shall be colour coded and shall be supported on glass fiber reinforced thermosetting plastic insulated supports at regular intervals to withstand the force arising from in case of short circuit in the system. All bus bar shall be provided in a

separate chamber and all connections shall be done by bolting. Additional cross sectional area shall be added to the bus bar to compensate for the holes. All connections between bus bar and breaker shall be through solid aluminium strips of proper size to carry full rated current as per approved for construction shop drawing and insulated with insulating sleeves. Bus bar shall be rated for current density of 1.0 amps/mm^2 cross section area.

8. TEMPERATURE - RISE LIMIT

Unless otherwise specified, in the case of external surface of enclosures of bus bar trunking system which shall be accessible but do not need to be touched during normal operation, an increase in the temperature rise limits of 25° C above ambient temperature shall be permissible for metal surface and of 15° C above ambient temperature for insulating surfaces as per relevant IS Codes.

9. CABLE COMPARTMENTS

Cable compartment of adequate size shall be provided in the control panel for easy clamping of all incoming and outgoing cables entering from the top/bottom. Adequate supports shall be provided in cable compartment to support cables as per approved for construction shop drawing.

10. MOULDED CASE CIRCUIT BREAKER (MCCB)

All MCCB's shall be motor duty and Current Limiting type, and comprise of Quick Make - break switching mechanism, preferably Double Break Contact system, arc extinguishing device and the tripping unit shall be contained in a compact, high strength, heat resistant, flame retardant, insulating moulded case with high withstand capability against thermal and mechanical stresses. All MCCB's shall be capable of defined Variable overload adjustment. All MCCB's rated 200 Amps and above shall have adjustable Magnetic short circuit pick up.

The trip command shall override all other commands. MCCB shall employ maintenance free double break contact system to minimise the let thru' energies and capable of achieving discrimination upto full short circuit capacity of downstream MCCB. The manufacturer shall provide both discrimination tables and let thru energy curves.

The breaking capacity of MCCB's shall be asked for in the schedule of quantities. The breaking capacities specified will be ICU=ICS i.e type-2. Co-ordination as per relevant IS and IEC Codes.

The MCCB's shall be provided with rotary handle operating mechanism. The handle position shall give positive indication of 'ON', 'OFF' or 'Tripped' thus qualifying to Disconnection as per the IS/IEC indicating the true position of all the contacts. In case of 4 pole MCCB the neutral shall be defined and capable of offering protection.

11. MINIATURE CIRCUIT BREAKER (MCB)

Miniature Circuit Breaker shall comply with relevant IS Codes and shall be quick make and break type for 230/415 VAC 50 Hz application with magnetic thermal

release for over current and short circuit protection. The breaking capacity shall not be less than 10 KA at 415 VAC. MCBs shall be DIN mounted. The MCB shall be Current Limiting type (Class-3). MCBs shall be classified (B,C,D ref IS standard) as per their Tripping Characteristic curves defined by the manufacturer. The MCB shall have the minimum power loss (Watts) per pole defined as per the IS/IEC and the manufacturer shall publish the values.

The housing shall be heat resistant and having a high impact strength. The terminals shall be protected against finger contact to IP20 Degree of protection. All DP, TP and TPN miniature circuit breakers shall have a common trip bar independent to the external operating handle.

12. PAINTING

All sheet steel work shall undergo a process of degreasing, pickling in acid, cold rinsing, phosphating, passivating (seven tank processing) and then painted with electrostatic paint (Powder coating). The shade of colour of panel inside/outside shall be as per relevant BIS code.

13. LABELS

Engraved PVC labels shall be provided on all incoming and outgoing feeder. Circuit diagram showing the arrangements of the circuit inside the control panel shall be pasted on inside of the panel door and covered with transparent plastic sheet.

14. METERS

i. All voltmeters and indicating lamps shall be through MCB's.

ii. Meters and indicating instruments shall be plug type.

iii. All CT's connection for meters shall be through Test Terminal Block (TTB).

iv. CT ratio and burdens shall be as specified on the Single line diagram.

15. CURRENT TRANSFORMERS

Current transformers shall be provided for Control panels carrying current in excess of 60 amps. All phase shall be provided with current transformers of suitable VA burden with 5 amps secondaries for operation of associated metering.

The CTs shall confirm to relevant Indian Standards. The design and construction shall be dry type, epoxy resin cast robust to withstand thermal and dynamic stresses during short circuits. Secondary terminals of CTs shall be brought out suitable to a terminal block which shall be easily accessible for testing and terminal connections. The protection CTs shall be of accuracy class 5P10 and measurement CTs shall be of accuracy class I.

16. SELECTOR SWITCH

Where called for, selector switches of rated capacity shall be provided in control panels, to give the choice of operating equipment in selective mode.

17. STARTERS

Each motor shall be provided with a starter of suitable rating. Starters shall be in accordance with relevant IS Codes. All Star Delta and ATS Starters shall be fully automatic.

18. CONTACTOR

Contactor shall be built into a high strength thermoplastic body and shall be provided with an arc shield for quick arc extinguishing. Silver alloy tips shall be provided to ensure a high degree of reliability and endurance under continuous operation. The magnet system shall consist of laminated yoke and armature to ensure clean operation without hum or chatter.

Starters contactors shall have 3 main and 2 Nos. NO / NC auxiliary contacts and shall be air break type suitable for making and breaking contact at minimum power factor of 0.35. For design consideration of contactors the starting current of connected motor shall be assumed to be 6 times the full load current of the motor in case of direct-on-line starters and 3 times the full load current of the motor in case of Star Delta and Reduced Voltage Starters. The insulation for contactor coils shall be of Class “E”.
Coil shall be tape wound vacuum impregnated and shall be housed in a thermostatic bobbin, suitable for tropical conditions and shall withstand voltage fluctuations. Coil shall be suitable for 220/415±10% volts AC, 50 cycles AC supply.

19. THERMAL OVERLOAD RELAY

Thermal over load relay shall have built in phase failure sensitive tripping mechanism to prevent against single phasing as well as on overloading. The relay shall operate on the differential system of protection to safeguard against three phase overload, single phasing and unbalanced voltage conditions.

Auto-manual conversion facility shall be provided to convert from auto-reset mode to manual-reset mode and vice-versa at site. Ambient temperature compensation shall be provided for variation in ambient temperature from -5° C to +55°C.

All overload relays shall be of three element, positive acting ambient temperature compensated time lagged thermal over load relays with adjustable setting. Relays shall be directly connected for motors upto 35 HP capacity. C.T. operated relays shall be provided for motors above 35 HP capacity. Heater circuit contactors may not be provided with overload relays.

20. TIME DELAY RELAYS

Time delay relays shall be adjustable type with time delay adjustment from 0-180 seconds and shall have one set of auxiliary contacts for indicating lamp connection.

21. INDICATING LAMP AND METERING

All meters and indicating lamps shall be in accordance with IS:1248 and IS-1258. The meters shall be flush mounted type. The indicating lamp shall be of low wattage . Each

MCC and control panel shall be provided with voltmeter 0-500 volts with three way and off selector switch, CT operated ammeter of suitable range with three nos. CTS of suitable ratio with three way and off selector switch, phase indicating lamps, and other indicating lamps as called for. Each phase indicating lamp shall be backed up with 5 MCB. Other indicating lamps shall be backed up with fuses as called for in Schedule of Quantities.

22. TOGGLE SWITCH

Toggle switches, where called for in Schedule of Quantities, shall be in conformity with relevant IS Codes and shall be of 5 amps rating.

23. PUSH BUTTON STATIONS

Push button stations shall be provided for manual starting and stopping of motors / equipment Green and Red colour push buttons shall be provided for 'Starting' and 'Stopping' operations. 'Start' or 'Stop' indicating flaps shall be provided for push buttons. Push Buttons shall be suitable for panel mounting and accessible from front without opening door, Lock lever shall be provided for 'Stop' push buttons. The push button contacts shall be suitable for 6 amps current capacity.

24. CONDUITS

Conduits and Accessories shall conform to relevant Indian Standards. Wall thickness shall be 16 gauge upto 32 mm dia and 14 gauge above 32 mm dia conduit. Screwed G.I. Conduits shall be used. Joints between conduits and accessories shall be securely made, to ensure earth continuity. All conduit accessories shall be threaded type only. All raw metal shall be painted with bitumastic paint.

Only approved make of conduits and accessories shall be used.

Conduits shall be delivered to the site of construction in original bundles and each length of conduit shall bear the label of the manufacturer.

Maximum permissible number of 650/1100 volt grade PVC insulated wires that may be drawn into rigid non metallic or GI Conduits are given below :

Size of wires Nominal Cross section Area (Sq. mm.)	**Maximum number of wires within conduit size(mm)**				
	20	**25**	**32**	**40**	**50**
1.5	5	10	14	--	--
2.5	5	8	12	--	--
4	3	7	10	--	--
6	2	5	8	--	--
10	--	3	5	6	--
16	--	2	3	--	6
25	--	--	2	4	6
35	--	--	--	3	5

25. CABLES

M.V. Cables shall be PVC insulated aluminium conductor and armoured cables conforming to IS Codes. Cables shall be armoured and suitable for laying in trenches, ducts, and on cable trays as required. M.V. Cables shall be termite resistant. Cable glands shall be double compression glands. Control cables and indicating panel cables shall be multi core PVC insulated copper conductor and armoured cables.

26. CABLE LAYING

Cable shall be laid in accordance with IS code of Practice. Cables shall be laid on 14 gage factory fabricated perforated galvanized sheet steel cable trays, and cable drops / risers shall be fixed to ladder type cable trays factory fabricated out of galvanized steel angle. Access to all cables shall be provided to allow cable withdrawal / replacement in the future. Where more than one cable is running on a cable tray, one dia spacing shall be provided between cables to minimise the loss in current carrying capacity.

Cables shall be suitably supported with Galvanized saddles when run on walls / trays. When buried, they shall be laid in 350 mm wide and 750 mm deep trench and shall be covered with 250 mm thick layer of soft sifted sand & protected with bricks/tiles. Special care shall be taken to ensure that the cables are not damaged at bends. The radius of bend of the cables when installed shall not be less than 12 times the diameter of cable.

27. WIRE AND WIRE SIZES

1100 volts grade PVC insulted copper conductor wires in conduit shall be used.

For all single phase/ 3 phase wiring, 1100 volts grade PVC insulated copper conductor wires shall be used. The equipment inside plant room shall be connected to the control panel by means of insulated copper conductor wires of adequate size in exposed conduits. Final connections to the equipment shall be through wiring enclosed in galvanized flexible conduits rigidly clamped at both ends and at regular intervals. An isolator shall be provided near each motor/equipment wherever the motor/equipment is separated from the supply panel through a partition barrier or through ceiling construction. PVC insulated copper conductor wires shall be used inside the control panel for connecting different components and all the wires inside the control panel shall be neatly dressed and plastic beads shall be provided at both the ends for easy identification of control wiring.

The minimum size of control wiring shall be 1.5 sq. mm PVC insulated stranded soft drawn copper conductor wires drawn through conduit to be provided for connecting equipment and control panels.

Power wiring, cabling shall be of the following sizes:

1. Upto 5 HP motors/ 5 KW heaters 3 x 4 sq. mm copper conductor wires.
2. From 6 HP to 10 HP motors/ KW to 7.5 KW heaters 3 x 6 sq. mm copper conductor wires
3. From 12.5 HP to 15 HP wires 2 Nos. 3 x 6 sq. mm copper conductor wires
4. From 20 HP to 25 HP motors 2 Nos. 3 x 10 sq. mm copper conductor wires
5. From 30 HP to 35 HP motors 2 nos.3x 16 sq.mm aluminium conductor armoured cable.
6. From 40 HP to 50 HP motors 2 Nos. 3x25 sq.mm aluminium conductor armoured cable.

7. From 60 HP to 75 HP motors 1 No. 3 x 70 sq. mm aluminium conductor armoured cable.

8. 100 HP motors conductor 1 No. 3 x 150 sq. mm. aluminium armoured cable
9. 200 HP motor conductor 2 No. 3 x 150 sq. mm. aluminium armoured cable.

All the switches, contactors, push button stations, indicating lamps shall be distinctly marked with a small description of the service installed. The following capacity contactors and overload relays shall be provided for different capacity motors or as per manufacturer's recommendation.

28. EARTHING

Earthing shall be provided in accordance with relevant BIS Codes and shall be copper strips /wires .The main panel shall be connected to main earthing system of the power supply. All single phase metal clad switches and control panels be earthed with minimum 3 mm diameter copper conductor wire. All 3 phase motors and equipment shall be earthed with 2 numbers distinct and independent copper wires / tapes as follows:

i. Motor upto and including 10 HP rating.	2 No. 3 mm dia copper wires.
ii. Motor 12.5 HP to 40 HP capacity	2 No. 4 mm dia copper wires
iii. Motor 50 to 75 HP capacity.	2 No. 6 mm dia copper
iv. Motor above 75 HP.	2 No. 25 mm x 3 mm copper tapes.

All switches shall be earthed with two numbers distinct and independent copper wires' tapes as follows:

i. 3 phase switches and control panels upto 60 amps rating.	2 No. 3 mm dia copper wires.
ii. 3 phase switches, and control panels 63 amps to 100 amps rating.	2 No. 4 mm dia copper wires.
iii. 3 phase switches and control panels 125 amps to 200 amps rating.	2 No. 6 mm dia copper wires.
iv. 3 phase switches, control panels, bus ducts, above 200 amps rating.	2 No. 3 mm x 25 mm copper tapes.

The earthing connections shall be tapped off from the main earthing of electrical installation. The overlapping in earthing strips at joints where required shall be minimum 75 mm. These straight joints shall be riveted with brass rivets & brazed in approved manner. Sweated lugs of adequate capacity and size shall be used for all termination of wires. Lugs shall be bolted to the equipment body to be earthed after the metal body is cleaned of paint and other oily substance, and properly tinned.

29. DRAWINGS

Shop drawings for control panels and for wiring of equipment showing the route of conduit & cable shall be submitted by the contractor for approval of Architect/Consultant before starting the fabrication of panel and starting the work. On completion, four sets of complete "As-installed" drawings incorporating all details like, conduits routes, number of wires in conduit, location of panels, switches, junction/pull boxes and cables route etc. shall be furnished by the Contractor.

30. TESTING

Before commissioning of the equipment, the entire electrical installation shall be tested in accordance with relevant BIS codes and test report furnished by a qualified and authorised person. The entire electrical installation shall be gotten approved by Electrical Inspector and a certificate from Electrical Inspector shall be submitted. All tests shall be carried out in the presence of Project Manager. Testing of the panels shall be as per relevant BIS Codes :

31. PAINTING

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

32 MEASUREMENT OF ELECTRICAL CONTROL PANELS

Panels shall be counted as number of units. Quoted rates shall include as lumpsum (NOT measurable lengths) for all internal wiring, power wiring and earthing connections from the control panel to the starter and to the motor, control wiring for interlocking, power and control wiring for automatic and safety controls, and control wiring for remote start/stop as well as indication as per the specifications. The quoted rate of panel shall also include all accessories, switchgear, contactors, indicating meters and lights as per the Specifications and Schedule of Quantities.

33. RUBBER MAT

Rubber mat shall be provided in front to cover the full length of all panels. Where back space is provided for working from the rear of the panel, rubber mat shall also be provided to cover the full length of panel.

SECTION - 10 :: COMMISSIONING & GUARANTEE

1. SCOPE OF WORK

Work under this section shall be executed without any additional cost. The rates quoted in this tender shall be inclusive of the works given in this section.

Contractor shall provide all tools, equipment, metering and testing devices required for the purpose.

On award of work, Contractor shall submit a detailed proposal giving methods of testing and gauging the performance of the equipment to be supplied and installed under this contract.

All tests shall be made in the presence of the Architect or his representative or any inspecting authority. At least five working days notice in writing shall be given to the inspecting parties before performing any test.

Water flow rates of all equipment and in pipe lines through valves shall be adjusted to design conditions. Complete results of adjustments shall be recorded and submitted.

Contractor shall ensure proper balancing of the hydraulic system and for the pipes / valves installed in his scope of work by regulating the flow rates in the pipe line by valve operation. The contractor shall also provide permanent Tee connection (with plug) in water supply lines for ease of installing pressure gauge, temperature gauge & rota meters. Contractor shall also supply all required pressure gauge, temperature gauge & rotameter for system commissioning and balancing. The balancing shall be to the satisfaction of Consultant / Project Manager.

Three copies of all test results shall be submitted to the Engineer in A4 size sheet paper within two weeks after completion of the tests.

2. PRECOMMISSIONNIG

On completion of the installation of all pumps, piping, valves, pipe connections, insulation etc. the Contractor shall proceed as follows:

a. Prior to start-up and hydraulic testing, the Contractor shall clean the entire installation including all fitments and pipe work and the like after installation and keep them in a new condition. All pumping systems shall be flushed and drained at least once through to get rid of contaminating materials. All pipes shall be rodded to ensure clearance of debris, cleaning and flushing shall be carried out in sections as the installation becomes completed.

b. All strainers shall be inspected and cleaned out or replaced.

c. When the entire systems are reasonably clean, a pre-treatment chemical shall be introduced and circulated for at least 8 hours. Warning signs shall be provided at all outlets during pre- treatment. The pre-treatment chemical shall:

· Remove oil, grease and foreign residue from the pipe work and fittings;

· Pre-condition the metal surfaces to resist reaction with water or air.

d· Establish an initial protective film;

· After pre-treatment, the system shall be drained and refilled with fresh water and left until the system is put into operation.

· Details and procedures of the pre-treatment shall be submitted to the Architect for approval.

e. Check all clamps, supports and hangers provided for the pipes. Check all the equipment, piping and valves coming under hot water system and operate each and every valve on the system to see if the valves are functioning properly. Thereafter conduct & hydro test of the system as for (b) above.

f. Fill up pipes with water and apply hydrostatic pressure to the system as given in the relevant section of the specification. If any leakage is found, rectify the same and retest the pipes.

Fire Protection System

a. Check all hydrant valves by opening and closing : any valve found to be open shall be closed.

b. Check all the piping under hydro test.

c. Check that all suction and delivery connections are properly made for all pump sets.

d. Check rotation of each motor after decoupling and correct the same if required.

e. Test run each pump set.

f. All pump sets shall be run continuously for 8 hours (if required with temporary piping back to the tank).

Commissioning and Testing

a. Pressurise the fire hydrant system by running the jockey pump and after it attains the shutoff pressure of the pump , then

b. Open bypass valve and allow the pressure to drop in the system. Check that the jockey pump cuts-in and cuts-out at the preset pressure. If necessary adjust the pressure switch for the jockey pump. Close by-pass valve.

c. Open hydrant valve and allow the water to below into the fire water tank in order to avoid wastage of water. The main fire pump shall cut-in at the preset pressure and shall not cutout automatically on reaching the normal line pressure. The main fire pump shall stop only by manual push button. However the jockey pump shall cut-out as soon as the main pump starts,

d. Switch off the main fire pump and test check the diesel engine driven pump in the same manner as the electrically driven pump,

e. When the fire pumps have been checked for satisfactory working on automatic controls, open fire hydrant valves simultaneously and allow the hose pipes to discharge water into the fire tank to avoid wastage.

f. Check each landing valve, male and female couplings and branch pipes, for compatibility with each other. Any fitting which is found to be incompatible and do not fit into the other properly shall be replace by the Contractor. Each landing valve shall also be checked by opening and closing under pressure.

g. Check all annunciations by simulating the alarm conditions at site.

Sprinkler System

a. Start the sprinkler pump and develop the required pressure in the sprinkler pipes.

b. Open the test valve to test the automatic starting of the pump. If necessary , make necessary adjustments in the setting of pressure switch. The sprinkler water gong alarm shall also operate when the test valve is open. This operation is to be done for each and every section of the sprinkler system and the alarm for each section (via flow switch) shall be checked for operation.

c. After satisfactory operation of the pump the Contractor shall set up mock fire and test the system.

d. Check all annunciations by simulating the alarm conditions at site.

3. STATUTORY AUTHORITIES' TESTS AND INSPECTIONS

As and when notified in writing or instructed by the Architect, the Contractor shall submit shop drawing and attend all tests and inspections carried out by Local Fire Authorities, Water Authority and other Statutory Authorities, and shall forthwith execute free of charge any rectification work ordered by the Architect as a result of such tests and inspections where these indicate non-compliance with Statutory Regulations. Some of these tests may take place after the issue of Practical Completion of the Main Contract and the Contractor shall make all allowances in this respect.

The Contractor shall be responsible for the submission of all necessary forms and shop drawings to the Statutory Authorities which shall conform in layout to the latest architectural plans submitted to and kept by these Authorities.

The submission shall comply with the requirements set forth in the current Codes of Practice and circular letters of the Statutory Authorities. The shop drawings to be submitted shall be forwarded to the Architect for checking before submission.

The Contractor shall allow for at least two submissions of complete sets of shop drawings to the Authorities, one to be made within six months after the award of the Contract but not less than six weeks before the inspection. The Architect may at his discretion instruct the Contractor for additional submissions to the Local Authorities whenever necessary.

The Contractor shall notify the Architect at least seven days in advance of his application for local Authority tests and inspections. On receipt of a confirmed date for test and inspection the Contractor shall inform the Architect without delay.

4. FINAL ACCEPTANCE TESTS

Following commissioning and inspection of the entire installation, and prior to issue of the Completion Certificate, the Contractor shall carry out final acceptance tests in accordance with a programme to be agreed with the Architect.

Should the results of the acceptance tests show that plant, systems and/or equipment fail to perform to the efficiencies or other performance figures as given in this

Specification, the Contractor shall adjust, modify and if necessary replace the equipment without further payment in order that the required performance is obtained.

Where acceptance tests are required by the relevant Authorities having jurisdiction, these tests shall be carried out by the Contractor prior to the issue of Completion Certificate to the acceptance of the Authorities.

5. REJECTION OF INSTALLATION / PLANT

Any item of plant or system or component which fails to comply with the requirements of this Specification in any respect whatsoever at any stage of manufacture, test, erection or on completion at site may be rejected by the Architect either in whole or in part as he considers necessary/appropriate. Adjustment and/or modification work as required by the Architect so as to comply with the Authority's requirements and the intent of the Specification shall be carried out by the Contractor at his own expense and to the satisfaction of the Authority/Architect.

After works have been accepted, the Contractor may be required to carry out assist in carrying out additional performance tests as reasonably required by the Architect/Employer.

6. WARRANTY AND HANDOVER

The Contractor shall warrant that all plant, materials and equipment supplied and all workmanship performed by him to be free from defects of whatsoever nature before handover to the Owner.

7. HANDING OVER OF DOCUMENTS

All testing and commissioning shall be done by the Contractor to the entire satisfaction of the Owner’s site representative and all testing and commissioning documents shall be handed over to the Owner’s site representative.

The Contractor shall also hand over all maintenance and operation manuals, all certificates and all other documentation as per the terms of the contract to the Owner’s site representative.

8. PIPE COLOUR CODE

S.No.	Pipe Lines	Ground / Base Colour	First Colour Band	Second Colour Band
1.	Cooling Water	Sea Green	French Blue	
4.	Drinking Water (All cold water lines after filter)	Sea Green	French Blue	Single Red
5.	Treated Water (Soft Water)	Sea Green	Light Orange	
6.	Domestic Hot Water	Sea Green	Light Grey	

9.	Drainage (Storm Water)	Black
10.	Drainage (Sewage Water)	Brown
12.	Fire System	Post Office Red

9. CHECK LIST FOR COMMISSIONING

Fire Protection System

a. Check all hydrant & other valves by opening and closing. Any valve found to be open shall be closed.

b. Check all clamps, supports and hangers provided for the pipes.

c. All the pump sets shall be run continuously for 30 minutes (with temporary piping back to tank from the nearest hydrant, using canvas hose pipes).

d. Fire Hydrant System - Pressurise the fire hydrant system by running the jockey pump and after it attains the shutoff pressure of the pump, then

Open bypass valve and allow the pressure to drop in the system. Check that the jockey pump cuts-in and cuts-out at the preset pressure. If necessary adjust the pressure switch for the jockey pump. Close by-pass valve.

Open hydrant valve and allow the water to flow into the fire water tank in order to avoid wastage of water. The main fire pump shall cut-in at the preset pressure and shall not cutout automatically on reaching the normal line pressure. The main fire pump shall stop only by manual push button. However the jockey pump shall cut-out as soon as the main pump starts.

Operate booster pump continuously for 30 minutes with piping back to underground tanks from the hydrant nearest to plant room.

Check each landing valve, male and female couplings and branch pipes, for compatibility with each other. Any fitting which is found to be incompatible and do not fit into the other properly shall be replaced by the Contractor. Each landing valve shall also be checked by opening and closing under pressure.

Check air cushion tanks on the terrace for proper functioning.

Water Supply / Water Treatment Equipment & Hot Water System

<u>Common</u>

a. Operate each and every valve on the system to see if the valves are functioning properly.

b. Check all clamps, support and hangers provided for the pipes.

c. Check rotation of each motor and correct the same if required.

d. All the pumps shall run continuously for one hour. Record the pressure and motor current and voltage readings.

e. Check all annunciations by simulating the alarm conditions if any at site.

Water Supply and Drainage

a. Remove grease trap manhole covers. Check for cleanliness, check for partitions, and put back the cover.

b. Remove manhole covers on sewer lines, inspect for cleanliness. After they are found to be clean, pour water into the first manhole and see that all the lines are clear. Make sure that all the covers are put back after the inspection.

c. Check gully traps by opening of covers and check that water seal in the traps are maintained. Check for general cleanliness.

d. Check installation of proper vents and cowls at the roof level for all soil and waste pipes.

e. Performance test to be carried out and recorded in the following table for the pumps.

S. No.	**Pump Tag No.**	**Model No.**	**Design Flow LPS**	**Actual Flow LPS**	**△P kg/cm^2**	**Full load Amps**	**Remarks**
i.	Domestic Water Hydro-pneumatic Pump No. 1						
ii.	Domestic Water Hydro-pneumatic Pump No. 2						
iv.	Filter feed Pump no. 1						
v.	Filter feed Pump no. 2						
vi.	Softener transfer Pump no. 1						
vii	Softener transfer Pump no. 2						

f. Simulate low level in the domestic water tanks to trip domestic Filter Feed Pumps. Simulate high level in treated water tanks to trip softener feed pumps. Simulate low level in treated water tanks to trip treated water hydro-pneumatic pumps.

Submersible Sump Pumps

a. Fill the sump with water, while observing the level.

b. Keep the pump starter switch on 'OFF' position to check for start of pump.

c. By keeping the starter switch on 'Auto' position, both the pumps should start. As the water level starts receeding, one pump should switch off by itself. The second pump should switch off on further reduction in water level.

d. Fill the sump with a little water and check both the pumps in 'Manual' position momentarily.

e. Leave the switches in 'Auto' position for both the pumps.

Softening Plant

The plant shall be run for 3 regenerations + 3 service cycles to establish output, quality of treated water.

3. STATUTORY AUTHORITIES' TESTS AND INSPECTIONS

As and when notified in writing or instructed by the Architect, the Contractor shall submit shop drawing and attend all tests and inspections carried out by Local Fire Authorities, Water Authority and other Statutory Authorities, and shall forthwith execute free of charge any rectification work ordered by the Architect as a result of such tests and inspections where these indicate non-compliance with Statutory Regulations. Some of these tests may take place after the issue of Practical Completion of the Main Contract and the Contractor shall make all allowances in this respect.

The Contractor shall be responsible for the submission of all necessary forms and shop drawings to the Statutory Authorities which shall conform in layout to the latest architectural plans submitted to and kept by these Authorities.

The submission shall comply with the requirements set forth in the current Codes of Practice and circular letters of the Statutory Authorities. The shop drawings to be submitted shall be forwarded to the Architect for checking before submission.

The Contractor shall allow for at least two submissions of complete sets of shop drawings to the Authorities, one to be made within six months after the award of the Contract but not less than six weeks before the inspection. The Architect may at his discretion instruct the Contractor for additional submissions to the Local Authorities whenever necessary.

The Contractor shall notify the Architect at least seven days in advance of his application for local Authority tests and inspections. On receipt of a confirmed date for test and inspection the Contractor shall inform the Architect without delay.

4. FINAL ACCEPTANCE TESTS

Following commissioning and inspection of the entire installation, and prior to issue of the Completion Certificate, the Contractor shall carry out final acceptance tests in accordance with a programme to be agreed with the Architect.

Should the results of the acceptance tests show that plant, systems and/or equipment fail to perform to the efficiencies or other performance figures as given in this Specification, the Contractor shall adjust, modify and if necessary replace the equipment without further payment in order that the required performance is obtained.

Where acceptance tests are required by the relevant Authorities having jurisdiction, these tests shall be carried out by the Contractor prior to the issue of Completion Certificate to the acceptance of the Authorities.

5. REJECTION OF INSTALLATION / PLANT

Any item of plant or system or component which fails to comply with the requirements of this Specification in any respect whatsoever at any stage of manufacture, test, erection or on completion at site may be rejected by the Architect either in whole or in part as he considers necessary/appropriate. Adjustment and/or modification work as required by the Architect so as to comply with the Authority's requirements and the intent of the Specification shall be carried out by the Contractor at his own expense and to the satisfaction of the Authority/Architect.

After works have been accepted, the Contractor may be required to carry out assist in carrying out additional performance tests as reasonably required by the Architect/Employer.

6. WARRANTY AND HANDOVER

The Contractor shall warrant that all plant, materials and equipment supplied and all workmanship performed by him to be free from defects of whatsoever nature before handover to the Owner.

7. HANDING OVER OF DOCUMENTS

All testing and commissioning shall be done by the Contractor to the entire satisfaction of the Owner’s site representative and all testing and commissioning documents shall be handed over to the Owner’s site representative.

The Contractor shall also hand over all maintenance and operation manuals, all certificates and all other documentation as per the terms of the contract to the Owner’s site representative.

8. PIPE COLOUR CODE

S.No.	Pipe Lines	Ground / Base Colour	First Colour Band	Second Colour Band
1.	Cooling Water	Sea Green	French Blue	
4.	Drinking Water (All cold water lines after filter)	Sea Green	French Blue	Single Red

5.	Treated Water (Soft Water)	Sea Green	Light Orange
6.	Domestic Hot Water	Sea Green	Light Grey
9.	Drainage (Storm Water)	Black	
10.	Drainage (Sewage Water)	Brown	
12.	Fire System	Post Office Red	

9. CHECK LIST FOR COMMISSIONING

Fire Protection System

a. Check all hydrant & other valves by opening and closing. Any valve found to be open shall be closed.

b. Check all clamps, supports and hangers provided for the pipes.

c. All the pump sets shall be run continuously for 30 minutes (with temporary piping back to tank from the nearest hydrant, using canvas hose pipes).

d. Fire Hydrant System - Pressurise the fire hydrant system by running the jockey pump and after it attains the shutoff pressure of the pump, then

Open bypass valve and allow the pressure to drop in the system. Check that the jockey pump cuts-in and cuts-out at the preset pressure. If necessary adjust the pressure switch for the jockey pump. Close by-pass valve.

Open hydrant valve and allow the water to flow into the fire water tank in order to avoid wastage of water. The main fire pump shall cut-in at the preset pressure and shall not cutout automatically on reaching the normal line pressure. The main fire pump shall stop only by manual push button. However the jockey pump shall cut-out as soon as the main pump starts.

Operate booster pump continuously for 30 minutes with piping back to underground tanks from the hydrant nearest to plant room.

Check each landing valve, male and female couplings and branch pipes, for compatibility with each other. Any fitting which is found to be incompatible and do not fit into the other properly shall be replaced by the Contractor. Each landing valve shall also be checked by opening and closing under pressure.

Check air cushion tanks on the terrace for proper functioning.

Water Supply / Water Treatment Equipment & Hot Water System

Common

a. Operate each and every valve on the system to see if the valves are functioning properly.

b. Check all clamps, support and hangers provided for the pipes.

c. Check rotation of each motor and correct the same if required.

d. All the pumps shall run continuously for one hour. Record the pressure and motor current and voltage readings.

e. Check all annunciations by simulating the alarm conditions if any at site.

Water Supply and Drainage

a. Remove grease trap manhole covers. Check for cleanliness, check for partitions, and put back the cover.

b. Remove manhole covers on sewer lines, inspect for cleanliness. After they are found to be clean, pour water into the first manhole and see that all the lines are clear. Make sure that all the covers are put back after the inspection.

c. Check gully traps by opening of covers and check that water seal in the traps are maintained. Check for general cleanliness.

d. Check installation of proper vents and cowls at the roof level for all soil and waste pipes.

e. Performance test to be carried out and recorded in the following table for the pumps.

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f. Simulate low level in the domestic water tanks to trip domestic Filter Feed Pumps. Simulate high level in treated water tanks to trip softener feed pumps. Simulate low level in treated water tanks to trip treated water hydro-pneumatic pumps.

Submersible Sump Pumps

a. Fill the sump with water, while observing the level.

b. Keep the pump starter switch on ‘OFF’ position to check for start of pump.

c. By keeping the starter switch on ‘Auto’ position, both the pumps should start. As the water level starts receeding, one pump should switch off by itself. The second pump should switch off on further reduction in water level.

d. Fill the sump with a little water and check both the pumps in ‘Manual’ position momentarily.

e. Leave the switches in ‘Auto’ position for both the pumps.

Softening Plant

The plant shall be run for 3 service cycles to establish output & quality of treated water.

D. TECHNICAL SPECIFICATIONS

ELECTRICAL WORKS

D. TECHNICAL SPECIFICATIONS - ELECTRICAL WORKS
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D. TECHNICAL SPECIFICATIONS - ELECTRICAL WORKS

1. INTERNAL WIRING

1.1 SYSTEM OF WIRING

The system of wiring shall consist of PVC insulated copper stranded conductor flexible FRLS wires in metallic conduits and shall be concealed or surface mounted above false ceiling as called for.

1.2 GENERAL

Prior to laying and fixing of conduits, the contractor shall mark the conduit route, carefully examine the working drawings prepared by him and approved by the Consultant indicating the layout, satisfy himself about the non interference in the route, sufficiency of number and sizes of conduits, location of junction boxes, sizes and location of switch boxes and other relevant details. Any discrepancy found shall be brought to the notice of the Owner's site representative. Any modifications suggested by the contractor should get written approval before the actual laying of conduits is commenced.

In laying of conduits it is important that not more than two right angle bends are provided for each circuit without a pull box. No junction box shall be provided in the entire length of conduit run for drawing of wires. Only switch outlets, lighting fixture outlets, equipment power outlets and socket outlets shall be considered for drawing of wires.

1.3 METAL CONDUITS & ACCESSORIES

1.3.1 CONDUITS

Conduits and Accessories shall conform to latest edition of Indian Standards IS-9537 part 1 &2. 16/14 (16 gauge upto 32 & 14 gauge above 32 mm) gauge screwed GI or MS conduits as specified on BOQ shall be used. Joints between conduits and accessories shall be securely made by standard accessories, as per IS-2667, IS-3837 and IS-5133 to ensure earth continuity. All conduit accessories shall be threaded type only.

Only approved make of conduits and accessories shall be used.

Conduits shall be delivered to the site of construction in original bundles and each length of conduit shall bear the label of the manufacturer.

Note :

Whatever materials required to be billed by the Contractor should come on site with proper challan number and quantity mention on it.

1.3.2 JOINTS

All jointing shall be subject to the approval of the Owner's site representative. The threads and sockets shall be free from grease and oil. End termination of conduit on GI boxes shall be by means of hexagon check nuts & spring washer on both sides of the conduit. The joints in conduits shall be free of burrs to avoid damage to insulation of conductors while pulling them through the conduits.

1.3.3 RECESSED OR EXPOSED CONDUITS

All conduits shall be as per Schedule of Quantities.

1.3.4 FLEXIBLE CONDUITS

Flexible conduits shall be made of heavy gauge MS strip galvanized after making the spiral. Both edges of the strip to have interlocking to avoid opening up.

1.4 PVC CONDUIT AND ACCESSORIES

PVC Conduit

Conduits and accessories shall conform to latest edition of IS-9537 part 3 and shall be heavy duty wall thickness of 2.0 mm rigid tubes which are unscrewed without coupling and with plain ends. All conduits used shall not be less than 20 mm diameter.

PVC conduit shall be used for all concealed / embedded installation.

PVC Conduit Accessories

Accessories used for conduit shall be of an approved type complying to relevant IS code.

All accessories used shall be of standard white or black colour, identical to conduit used.

Plain conduits shall be jointed by slip type of couplers with manufacturer's standard sealing cement.

All conduit entries to outlet boxes, trunking and switchgear are to be made with adaptors female thread and screwed male bushes.

PVC-switch and socket boxes with round knockouts are to be used. The colours of these boxes and the conduits shall be the same.

Standard PVC circular junction boxes are to be used with conduits for intersection, Tee-junction, angle-junction and terminal. For the drawing-in of cables, standard circular through boxes shall be used.

Samples of accessories shall be submitted for approval prior to installation.

All jointing of PVC conduits shall be by means of adhesive jointing. Adequate expansion joints shall be allowed to take up the expansion of PVC conduits.

1.5 BENDS IN CONDUIT

Where necessary, bends or diversions may be achieved by means of bends and / or circular cast iron boxes with inspection cover and with adequate and suitable inlet and outlet screwed joints. In case of recessed system each junction box shall be provided with a cover properly secured and flush with the finished wall surface. No bends shall have radius less than 7.5 cms or three times the outside diameter of the conduits.

1.6 **FIXING OF CONDUITS**

All conduits shall be installed so as to avoid steam, hot water or any other process pipes. After the conduits, junction boxes, outlet boxes and switch boxes are installed in position, their outlets shall be properly plugged or covered so that water, mortar, insects or another foreign matter does not enter into the conduit system. Surface conduits shall be fixed by means of heavy gauge GI saddles secured at intervals not more than 1000 mm, but on either side of couplers or bends or similar fitting saddles shall be fixed at a distance of 300 mm from centre of each fitting. For conduit fixing suitable PVC/Nylon fastners shall be used.

Recessed conduiting shall be done by making chase in the masonry by chase cutter, the conduit shall be fixed in the chase by means of GI hooks not more than 600 mm apart. After fixing of conduit the chase shall be filled with cement mortar after fixing of chicken mesh and brought to the original finish level of the surface.

1.7 **SWITCH OUTLETS AND JUNCTION BOXES**

All outlet boxes for switches, sockets and other receptacles shall be rust proof and shall be of 1.6 mm thick mild steel sheets with HOT dipped galvanizing (or as specified in BOQ), having smooth external and internal surfaces to true finish. All outlet boxes for receiving plug sockets and switches shall be fabricated to approve sizes. All boxes shall have adequate number of knock out holes of required diameter and earthing terminal screws. Outlet boxes shall be of a maximum depth of 65 mm.

1.8 **INSPECTION BOXES**

50 mm dia inspection boxes of cast iron shall have smooth external and internal finish to facilitate removal and replacement of wires, where required.

1.9 **FISH WIRE**

To facilitate subsequent drawing of wires in the conduit, GI fish wires of 2.0 mm (14 SWG) shall be provided alongwith the laying of recessed conduit.

1.10 **CONDUCTORS**

All PVC insulated copper conductor flexible FRLS wires shall conform in all respects to Standards as listed under sub-head Regulations and Standards and shall be IS approved and ISI marked.

1.11 **BUNCHING OF WIRES**

Wires carrying current shall be so bunched that the outgoing and return wires are drawn into the same conduit. Wires originating from two different phases shall not run in the same conduit. All wires shall have ferrules for identification. Lighting and power circuits shall be separate.

1.12 **DRAWING CONDUCTORS**

The drawing and jointing of PVC insulated copper conductor wires shall be executed with due regard to the following precautions. While drawing wires through conduits, care shall be taken to avoid scratches and kinks which may cause breakage of conductors. There shall be no sharp bends. Wire reel stands to be used for pulling of wires to avoid kinks.

Maximum permissible number of 1100 volt grade PVC insulated wires that may be drawn into metallic Conduits are given below :

Size of Wires Nominal Cross Section Area (Sq. mm.)	**Maximum number of wires within conduit size(mm)**				
	20	**25**	**32**	**40**	**50**
1.5	5	10	14	--	--
2.5	5	8	12	--	--
4	3	7	10	--	--
6	2	5	8	--	--
10	--	3	5	6	--
16	--	2	3	--	6
25	--	--	2	4	6
35	--	--	--	3	5

Insulation shall be removed by insulation stripper only. Strands of wires shall not be cut / reduced for connecting into terminals. The terminals shall have sufficient cross sectional area to take all strands and it's connecting brass screws shall have flats ends. All looped joints shall be connected through terminal block/connectors. The pressure applied to tighten terminal screws shall be just adequate, neither too much nor too less. All light points shall be terminated through a connector.

Condutors having nominal cross sectional areas exceeding 10 sq.mm shall always be provided with cable sockets. At all bolted terminals brass flat washer of large area and approved steel spring washer shall be used. Brass nuts and bolts shall be used for all connections.

Only licensed wiremen (Before doing the work or before appointing him on site contractor has to submit his wiring licence to Owner) and cable jointers shall be employed to do jointing work. All wires and cables shall be embossed with the manufacturer's label with ISI mark and shall be brought to site in original packing. For all internal wiring. PVC insulated wires of 1100 volts grade shall be used. The sub-circuit wiring for point shall be carried out in loop system and no joints shall be allowed in the length of the conductors. No wire shall be drawn into any conduit until all work of conduit installation of any nature that may cause injury to wire is completed. Care shall be taken while pulling out the wires so that no damage occurs to conduits/wire itself, the conduits shall be thoroughly cleaned of moisture, dust , dirt or any other obstruction. The minimum size of PVC insulated copper conductor wires for all sub-circuit wiring for light points shall be minimum 2.5 sq.mm copper. Separate neutral to be pulled for each circuit.

1.13 **JOINTS**

All joints shall be made at main switches, distribution boards socket outlets, lighting outlets and switches boxes only. No joints shall be made in conduits and in junction boxes. Conductors shall be continuous from outlet to inlet.

1.14 **MAINS AND SUB-MAINS**

Mains and sub-mains cable or wires where called for shall be of the rated capacity and approved make. Every main and sub main wires shall be drawn into an independent adequate size of conduit. Earthing shall be in conformity with relevant IS codes and

calculations shall be submitted for verification. An independent earth wire of the proper rating shall be provided for every single phase sub-main. For every 3 -phase sub-main, 2 No. earth wires of proper rating shall be provided along with the sub-main. The earth wires shall be drawn along with circuit wires through conduit. Where mains and sub-mains cables are connected to switchgear, sufficient extra lengths of cable shall be provided to facilitate easy connections and maintenance.

1.15 LOAD BALANCING

Balancing of circuits in three phase installation shall be as planned by the Consultants in the tender drawings and shall be checked by the contractor before the commencement of wiring and shall be strictly adhered to.

1.16 COLOUR CODE OF CONDUCTORS

Colour code shall be maintained as indicated by the Consultant for the entire wiring installations. Red, yellow, blue shall be for three phases, black for neutral and green with yellow band shall be for earthing.

2. SWITCHES, RECEPTACLES (MODULAR), LIGHTING FIXTURES & LIGHTING CONTROL EQUIPMENT

2.1 SWITCHES

All switches shall be enclosed type flush mounted suitable for 240 volts AC. All switches shall be fixed inside the switch boxes on adjustable flat M S strips/plates with tapped holes and brass machine screws, leaving ample space at the back and sides for accommodating wires. Switch controlling the light point shall be connected to the phase wire of the circuit and load on each switch shall be restricted to maximum 800 watts & maximum 1500 watts per circuit. All wiring accessories shall be BIS approved. Perfect alignment shall be maintained while fixing of the back boxes.

2.2 WALL SOCKET OUTLET

Wall socket outlets shall be of the three pin. The switch controlling the socket outlet shall be on the phase wire of the circuit and not more than two socket outlets of 16 amps shall be connected on one circuit. An earth wire shall be provided alongwith the circuit wires and shall be connected to earthing screw inside the box. The earth terminal of the socket shall be connected to the earth terminal provided inside the box. All sockets shall be shuttered type.

a. Every socket outlet shall be controlled by an individual switch unless mentioned otherwise.

b. The switch controlling the socket outlet shall be on the `Live' side of the line.

c. 6 amps and 16 amps socket outlet shall normally be fixed at any convenient height above the floor level as desired by the Architect. The switch for 6 and 16 amps, socket outlet shall be kept alongwith the socket outlet. However, in special case, if desired by the Architect the 6 amp. socket outlet can be placed at the normal switch level. 16 amps socket outlet in the kitchen of the residential or commercial

buildings shall be fixed at any convenient height above working platform or as specified in drawings / schedule of equipments.

d. In a room containing a fixed bath or shower, there shall be no socket outlet and there shall be no provision for connecting a portable appliance. Any stationary appliance connected permanently in the bath room shall be controlled by an isolator switch or circuit breaker having outlets at such location where water / moisture does not effect.

e. Where socket outlets are placed at lower level, they shall be enclosed in a suitable metallic box with the system of wiring adopted or shutter type sockets shall be provided as specified.

f. In an earthed system of supply, a socket outlet and plug shall be of three pin type, the third terminal shall be connected to earth.

g. Conductors connecting electrical appliance with socket outlet shall be flexible twin cord with an earthing cord which shall be secured by connecting between the earth terminal of plug and the metallic body of the electrical appliance.

h. Where use of shutter type of interlocking type of socket is required for any special installation, the items should be separately and specifically listed in the Schedule of Quantities of that particular work.

2.3 LIGHTING FIXTURES & ACCESSORIES

The light fixtures and fittings shall be assembled and installed in position complete and ready for service, in accordance with details, drawings, manufacturer's instructions and to the satisfaction of the Project Manager.

2.3.1 SCOPE

Scope of work under this section shall include inspection at suppliers/manufacturer’s premises at site, receiving at site, safe storage, transportation from point of storage to point of erection, erection and commissioning of light fittings, fixtures and accessories including all necessary supports, brackets, down rods and painting etc as required.

2.3.2 STANDARDS

The lighting and their associated accessories such as lamps, reflectors, housings, ballasts etc., shall comply with the latest applicable standards, more specifically the following:

General and safety requirements for Luminaires :
Part-1 Tubular flourescent lamps - IS – 1913 (Part-1)

Industrial lighting fittings with metal reflectors - IS - 1777

Decorative lighting outfits - IS - 5077

Bayonet lamp holders - IS - 1258

Bi-pin lamp holders for tubular fluorescent lamps - IS - 3323

Electronic Ballasts for fluorescent lamps – General & Safety requirement - IS – 13021 (Part-1)

Electronic Ballasts for fluorescent lamps – Performance requirement - IS – 13021 (Part-2)

Ballast for HP MV lamps - IS - 6616

Tubular Fluorescent lamps - IS - 2418 (Part-1 to 4)

Luminaries – General requirement - IS – 10322 (Part-1)

Luminaries – Constructional requirement - IS – 10322 (Part-2)

Luminaries – Screw and Screwless termination - IS – 10322 (Part-3)

Luminaries – Methods of Tests - IS – 10322 (Part-4)

Particular requirement – General purpose Luminaries - IS – 10322 (Part-5/Sec-1)

Particular requirement – Recessed Luminaries - IS – 10322 (Part-5/Sec-2)

Particular requirement – Luminaries for Road and Street lighting - IS – 10322 (Part-5/Sec-3)

Particular requirement – Portable General purpose Luminaries - IS – 10322 (Part-5/Sec-4)

Particular requirement – Flood Lighting - IS – 10322 (Part-5/Sec-5)

High pressure mercury vapour lamps - IS – 9900 (Part-1)

Tungsten filament general electric lamps - IS - 418

2.3.3 LIGHT FITTINGS-GENERAL REQUIREMENTS

a. Fittings shall be designed for continuous trouble free operation under atmospheric conditions without reduction in lamp life or without deterioration of materials and internal wiring. Degree of protection of enclosure shall be IP-65 for outdoor fittings except bulkhead fitting. Bulkhead fitting shall be provided with IP-54 protection.

b. Fittings shall be so designed as to facilitate easy maintenance including cleaning, replacement of lamps/ ballasts.

c. All fittings shall be supplied complete with lamps. All mercury vapour and sodium vapour lamp fittings shall be complete with accessories like ballasts,

power factor improvement capacitors, starters, etc. Out door type fittings shall be provided with weather proof junction boxes (IP-55) and IP-54 Control gear boxes. All fluorescent and CFL fittings shall be provided with electronic ballast as per schedule of quantities.

d. Each fitting shall have a terminal block suitable for loop-out connection by 1100 V PVC insulated copper conductor wires upto 4 sq.mm. the internal wiring should be completed by the manufacturer by means of standard copper wire and terminated on the terminal block.

e. All hardwares used in the fitting shall be suitably plated or anodized and passivated.

f. Earthing : Each lighting fitting shall be provided with an earthing terminal. All metal or metal enclosed parts of the housing shall be bonded and connected to the earthing terminal so as to ensure satisfactory earthing continuity throughout the fixture.

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

h. The housing shall be powder coated/stove-enamelled or anodised as required. The surface shall be scratch resistant and shall show no sign of cracking or flaking when bent through 90 deg. over 12 mm dia mandrel.

j. Metal used in BODY of lighting fixtures shall be not less than 22 SWG or heavier if so required to comply with specification of standards. Sheet steel reflectors shall have a thickness of not less than 20 SWG. The metal parts of the fixtures shall be completely free from burns and tool marks. Solder shall not be used as mechanical fastening device on any part of the fixture.

2.3.4 LIGHT FITTINGS – SPECIAL REQUIREMENTS

Box Channel Type Industrial Fittings

Box type slim line channel must be in screwless construction manufactured from M.S. CRCA sheet steel powder coated with MS CRCA cover, powder coated white. Light reflection surface in Box/Channel type fittings shall be in a POLYESTER PRECOATED STEEL having a reflection factor of not less than 80%. SCREWLESS DESIGN & CONSTRUCTION Light fixtures shall be preferred due to their ease of maintenance, especially for box/channel for box/channel type fixtures.

Moisture Proof Industrial Fittings

Surface mounted totally enclosed moisture proof fixtures must be in polycarbonate body and diffuser with transparent prismatic interior and smooth exterior and frosted end. Fixture must be completely sealed with polyerethane double gasket to achieve IP 65 protection. Fixture is complete with CRCA steel white powder coated / enameled finish reflector.

18 W / 36 W Fluorescent and 36 W CFL Low Glare Light Fittings

Recessed mounted, modular fluorescent lighting fixture made of CRCA Sheet steel powder coated (white) housing, electro chemically brightened and anodised reflector,

three dimensional cross louvers with concave contours, fresnel top at louver saddle to increase efficiency. The luminance of <200 cd/M^2 at 63 degree viewing angle in all directions so as to confirm Cat-2 classification of CIBSELG3

Highbay Industrial Fittings

Industrial Highbay luminaries shall be provided with pressure die cast housing along with all accessories, orthocyclically woundopien construction ballast, capacitor & semi parallel ignitor connected to terminal block and mounted on the gear plate. The gear shall have side entry for ease in maintenance. The spun aluminium reflector is suitable for narrows well as wide beam distribution as specified in schedule of quantities. The luminaire will be suitable for metal halide lamp HPI BU + 250 W which has 25500 lumens or similar 400W lamp and 2.5 minutes restrike time (when operate with son gear).

2.3.5 ACCESSORIES FOR LIGHT FITTINGS - REFLECTORS

The reflectors shall be made of CRCA sheet steel/aluminium /Silvered glass/Chromium plated sheet copper as specified. The thickness of reflectors shall be as per relevant standards. Reflectors made of steel shall have stove enameled/ vitreous enameled/epoxy coating finish. Aluminium used for reflectors shall be anodized/epoxy stove enameled /mirror polished. The finish for the reflector shall be as specified. The reflectors shall be free from scratches / blisters and shall have a smooth and glossy surface having optimum light reflecting coefficient. Reflectors shall be readily removable from the housing for cleaning and maintenance without use of tools.

2.3.6 LAMPS

2.3.6.1 TLD

Lamp shall be environment friendly low pressure mercury discharge lamp with mercury content less than or equal to 5 mg. The lamp shall have minimum lumen maintenance of 85 and CRI of 85. The lamp must comply to ROSH (Restriction of Hazardous substances) and covered by WEEE. Lamp should be fully re-cyclable. The lamp should be low on maintenance with life of 40 K hours in case of electromagnetic ballast and 65 K hours in case of HF ballast upto 10% failure. The discharge glass shall be lead free.

TLD Lamps shall be minimum tri-phosphor type and have bi-pin bases. Colour spectrum of light shall be equivalent to “PHILIPS color 84 or color 86 color 82 or “OSRAM color 21 or color 11 or color 41 (as required at site)”.

The fluorescent Tubes (TLD) should have cool daylight colour designation. But Architects reserve the right to prescribe either Cool Daylight or Bright White or Incandescent Colour Designations for TLD. NO extra payment will be made over the quoted rate of bidder for this. The 36 W fluorescent tubes will have Nominal Luminous Flux of not less than 3350 lumens whether so mentioned in the Schedule of Quantities or not.

T 5 – High Efficiency ECO-Friendly Lamps

T-5 lamp shall be environment friendly low pressure mercury discharge lamp with mercury content less than or equal to 3 mg. lamp should have lowest CO2 emission compared to any other comparable light source (40% less than a TL-D standard lamp, 26% less than TL-D / 80). T-5 lamp shall be 100% lead free. T-5 lamp shall be designed for operation with electronic gear and well suited for dimming. Maximum lumen output to be reached at approx 35°C in free burning position. T-5 lamp can be ignited from -15°C to + 50°C. Lamp should be fully recyclable and must comply to ROSH (Restriction of Hazardous substances) and shall be covered by WEEE. T-5 shall have 16 mm in diameter service life of TL-5 lamp should be 10% more than TL-D lamps. T-5 lamp shall have lumen efficacy of up to 104 Lumens / W and shall have excellent colour rendering to En 12464 (Ra 80 to 89).

2.3.6.2 Compact fluorescent lamp shall have same luminous flux and power consumption as fluorescent tubes but less than half the length and more compact than U-shaped and circulator lamps. CFL shall be suitable for use with conventional control gear & standers and for HF electronic control gear. CFL lamp shall be non integral type of OSRAM / GE / PHILIPS/ Havells Sylvania only.

2.3.7 HIGH FREQUENCY ELECTRONIC BALLAST

High frequency electronic ballast shall be used with fluorescent / Compact Fluorescent Lamps wherever specified in the schedule of quantities. High frequency electronic ballast shall comply to the following:

- IEC 927, IEC 928 for ≤10% total harmonic distortion.
- EMI / RFI – Confirming to FCC / VDE Class A/B.
- Line Transient as per IEEE C62.41.
- Ballast Crest Factor C1.7%.
- No Stroboscopic Effect
- Constant Wattage / Light output between 240 V ± 10%.*()*
- Circuit protection for surge current and inrush current.
- Short circuits, open lamp protection
- PF > 0.99 for fluorescent / T5 lamp and 0.95 for CFL.
- Deactivated lamp protection
- Suitable for use with single and twin lamps
- RFI < 30 MHz EN 55015
- Total Harmonic Distortion (THD) ≤10%
- Immunity to interference EN 61547
- Safety EN 60928 / IEC 928 / IS 13021 (Part I)
- Performance EN 60929 / IEC 929 / IS 13021 (Part II)
- Vibrations & Bump tests IEC 68-2-6 FC
  IEC 9001
- Quality Standard ISO 9001
- Environmental Standard ISO 14001
- DC Operation EN 60924
- Emergency Lighting Operation VDE 0108

Total System consumption (lamps + ballast) for

1 x 36 W TLD, shall not exceed 36 W
1 x 28 W T-5, shall not exceed 28 W
1 x 35 W T-5, shall not exceed 35 W
1 x 14 W T-5, shall not exceed 14 W
1 x 18 W CFL, shall not exceed 18 W
1 x 36 W CFL, shall not exceed 36 W

2.4 LIGHTING CONTROL EQUIPMENT PRODUCT SPECIFICATIONS

Light Level Sensor

The Light Level Sensor shall be capable of measuring ambient light levels in the range of 20 to 3000 lux (40 lux to 1600 lux controllable).

The ambient light level shall be measured by the Light Level Sensor and output devices (such as Dimmer Units) shall be controlled to maintain constant luminance in a given area, under varying conditions.

The target luminance level as well as the Margin shall be set using the control system Installation Software.

The Margin shall represent the maximum allowed variation (dead band) of the luminance level value in respect to the preset Target value. If the luminance level stays within the Margin, no action shall be taken by the sensor. The light level sensor shall incorporate filtering and hysteresis functions to suppress noise and compensate for rapid light intensity fluctuations.

If the natural ambient luminance level is such that extra illumination is not necessary, an off command shall be transmitted by the Light Level Sensor to the designated Output devices.

In the event of power cycling, a non-volatile memory (NVM) shall be incorporated to retain all address and switching information.

The field of View of the light level sensor shall be 180 degrees.

The Supply Voltage to each light level sensor shall be 36VDC @ 18mA. No additional 240V supply shall be required.

The light level sensor shall have an operating temperature range of 0-50 Degree C.

Temperature Sensor

The Temperature Sensor shall be suitable for measuring ambient temperature and issuing on or off commands to one (1) group address for heating or cooling purposes. The unit shall measure in the range 0 - 50 degree C with selectable offset (dead-band) within the installation software

The Temperature Sensor shall have the ability to change its target temperature to a different point (and to reset the target) by receiving bus commands from another system devices.

The unit shall have an Economy mode, which when set active shifts the whole operating range up or down (up for Cooling or down for Heating).

In the event of power cycling, a non-volatile memory (NVM) shall be incorporated to retain all address and switching information.

The Supply Voltage to each Temperature Sensor shall be 36VDC @ 18mA. No additional 240V supply shall be required.

PIR Occupancy Sensor

The PIR Occupancy Sensor shall detect passive infrared energy for control of any number of independent electrical loads. The light level shall be adjustable from the front of the unit and shall be used to disable the Occupancy Sensor. Timer settings shall be adjustable from 1 second to 18 hours, in one-second increments. A weatherproof version shall be available for outdoor or industrial use.

In the event of power cycling, a non-volatile memory (NVM) shall be incorporated to retain all address and switching information.

The Supply Voltage to each PIR Sensor shall be 36VDC @ 18mA. No additional 240V supply shall be required for the unit to operate.

The unit shall have suitable operating temperatures between 0-50 Degree C.

The unit shall be suitable for wall or ceiling mounting, up to mounting heights of 2.4m.

The Indoor unit shall have a field of view of 90 degrees. The outdoor unit shall have a field of view of 110 degrees.

The Indoor unit shall have an effective detection area of 6m x 6m. The outdoor unit shall have an effective detection area of 18m radius x 110 degrees.

The Indoor unit shall have 12 overlapping detection zones. The outdoor unit shall have 18 long range, 16 intermediate range, 10 short range and 4 ultra short-range detection zones.

Ultrasonic Occupancy Sensor

The unit shall be an active device utilizing Doppler wave technology as its means of detection. The unit shall include two air transducers to provide volumetric occupancy detection.

The unit shall be suitable for occupancy detection of larger areas, typically 12m x 12m and 2.7m mounting height. The unit shall include its own independent 240V power supply and shall require a socket outlet adjacent to installation point (typically in the lighting wiring loom). To enable the unit to communicate with the control system network, an Auxiliary Switch Input Unit shall be utilized. Each auxiliary unit will allow control of up to four detectors.

The unit will have easily accessible sensitivity adjustment that can be used to accommodate various room sizes.

The unit will have an indicator LED for walk-testing the unit.

The unit shall be ceiling mounted and a 360-degree field of view.

The unit shall utilize an ultrasonic frequency of 32.7 kHz.

The unit shall have suitable operating temperatures between 0-50 Degree C.

Combined Technology Ultrasonic/PIR Occupancy Sensor

The unit shall consist of two air transducers and four PIR detectors with a special lens to provide both volumetric and line of sight detection.

The unit shall be suitable for occupancy detection of larger areas, typically 15m x 15m and 2.7m mounting height. The unit shall include its own independent 240V power supply and shall require a socket outlet adjacent to installation point (typically in the lighting wiring loom). To enable the unit to communicate with the control system network, an Auxiliary Switch Input Unit shall be utilized. Each auxiliary unit will allow control of up to four detectors.

The unit shall be ceiling mounted and a 360-degree field of view.

The unit will have easily accessible sensitivity adjustment that can be used to accommodate various room sizes.

The unit will employ programmable walk-testing LED indicators: Red LED for Passive Infrared and Green LED for Ultrasonic modes.

The unit shall utilize an ultrasonic frequency of 32.7 kHz.

The unit shall have suitable operating temperatures between 0-50 Degree C.

Ultrasonic Occupancy Sensor for Corridors and Hallways

The unit shall be suitable for occupancy detection of Corridors and Hallways, typically up to 4.6m x 30m and 2.7m mounting height. The unit shall include its own independent 240V power supply and shall require a socket outlet adjacent to installation point (typically in the lighting wiring loom). To enable the unit to communicate with the control system network, an Auxiliary Switch Input Unit shall be utilized. Each auxiliary unit will allow control of up to four detectors.

The unit shall be ceiling mounted and a 360 degree field of view.

The unit will have an indicator LED for walk-testing the unit.

The unit shall utilize an ultrasonic frequency of 32.7 kHz.

The unit shall have suitable operating temperatures between 0-50 Degree C.

3. MEDIUM VOLTAGE 1.1 KV GRADE XLPE / PVC CABLES

3.1 GENERAL

The MV cables shall be supplied, inspected, laid, tested and commissioned in accordance with drawings, Specifications, relevant Standard Specifications and cable manufacturer's instruction or as per site requirement.

3.2 **MATERIAL**

The MV cables shall be cross linked polyethylene (XLPE) insulated PVC sheathed of 1100 volts grade as asked for in the schedule of quantities. Cables upto 16 sq.mm shall be with copper conductor and 25 sq.mm and above shall be with aluminium conductor.

3.3 **TECHNICAL REQUIREMENTS:**

3.3.1 All XLPE Aluminium/Copper Power cables shall be 1100 Volts grade, multi core constructed as per IS : 7098 Part-I of 1988 as follows :

a. Stranded Aluminium /Copper conductor in case of 10 sq.mm. and above whereas solid conductor in case of 10 sq.mm. and below.

b. Cores laid up

c. The inner sheath should be bonded over with thermo-plastic material for protection against mechanical and electrical damage.

d. Armoring should be provided over the inner sheath to guard against mechanical damage. Armouring should be Galvanised steel wires or galvanised steel strips. (In single core cables used in A.C. system armouring should be non-magnetic hard aluminium Wires/Strips. Round steel wires should be used where diameter over the inner sheath does not exceed 13 mm; above 13 mm flat steel armour should be used. Round wire of different sizes should be provided against specific request.)

e. The outer sheath should be specially formulated heat resistant black PVC compound conforming to the requirement of type ST2 of IS:5831-1984 extruded to form the outer sheath.

3.3.2 Conductor shall be of electrolytic Aluminium/Copper conforming to IS : 8130 and are compact circular or compact shaped.

3.3.3 Insulation shall be of XLPE type as per latest IS general purpose insulation for maximum rated conductor temperature 70 degree centigrade.

3.3.4 In Inner sheath laid up cores shall be bonded over with thermoplastic material for protection against mechanical and electrical damage.

3.3.5 Insulation, inner sheath and outer sheath shall be applied by extrusion and lapping up process only.

3.3.6 Armouring shall be of galvanised steel wire/flat.

3.3.7 Repaired cables shall not be used.

3.3.8 Current ratings of the cables shall be as per IS : 3961.

3.3.9 The XLPE insulated cables shall conform to latest revision of IS and shall be read along with this specification. The Conductor shall be stranded Aluminium/Copper circular/sector shaped and compacted. In multi core cables the core shall be identified by red, yellow, blue and black coloring of insulation.

3.3.10 The cables shall be suitable for laying in racks, ducts, trenches, conduits and underground buried Installation with uncontrolled back fill and chances of flooding by water.

3.3.11 Progressive automatic in line sequential marking of the length of cables in meters at every one meter shall be provided on the outer sheath of all cables.

3.3.12 Cables shall be supplied in non returnable wooden drums as per IS : 10418.

Both ends of the cables shall be properly sealed with PVC/Rubber caps so as to eliminate ingress of water during transportation, storage and erection.

3.3.13 The product should be coded as per IS :- 7098 Part-I as follows :-

Aluminium Conductor	A
XLPE Insulation	2X
Steel round wire armour	W
Steel strip armour	F
Steel Double round wire armour	WW
Steel Double strip armour	FF
Non-magnetic (Al.) round wire armour	Wa
Non-magnetic (Al.) strip armour	Fa
PVC outer sheath	Y

3.4 INSPECTION

All cables shall be inspected by the contractor upon receipt at site and checked for any damage during transit.

3.5 JOINTS IN CABLES

The Contractor shall take care to see that all the cables received at site are apportioned to various locations in such a manner as to ensure maximum utilization and avoid cable jointing. This apportioning shall be got approved by the Owner's site representative before the cables are cut to lengths. Where joints are unavoidable heat shrinkable type joints shall be made. The location of such joints shall be got approved from the Owner's site representative and shall be identified through a marker.

3.6 JOINTING BOXES FOR CABLES

Cable joint boxes shall be installed with heat shrinkable sleeve and of appropriate size, suitable for XLPE armoured cables of particular voltage rating.

3.7 JOINTING OF CABLES

All cable joints shall be made in suitable, approved cable joint boxes and the filling in of compound shall be done in accordance with manufactures' instructions and in an approved manner. All straight through joints shall be done in epoxy mould boxes with epoxy resin.

All cables shall be joined colour to colour and tested for continuity and insulation resistance before jointing commence. The seals of cables must not be removed until preparations for jointing are completed. Joints shall be finished on the same day as commenced and sufficient protection from the weather shall be arranged. The conductors shall be efficiently insulated with high voltage insulating tape and by using of spreaders of approved size and pattern. The joints shall be completely topped up with epoxy compound so as to ensure that the box is properly filled.

3.8 **CABLE END TERMINATIONS**

Cable end termination shall be done in cable terminal box using crimping sockets and proper size of glands of double compression type

3.9 **BONDING OF CABLES**

Where a cable enters any piece of apparatus, it shall be connected to the casing by means of an approved type of armour clamp and gland. The clamps must grip the armouring firmly to the gland or casing, so that no undue stress is passed on to the cable conductors.

3.10 **CABLE INSTALLATION**

Cables shall be laid by skilled and experienced workmen using adequate rollers to minimize stretching of the cable. The cable drums shall be placed on jacks before unwinding the cable. Great care shall be exercised in laying cables to avoid forming kinks.

3.10.1 LAYING OF CABLES ON CABLE TRAYS

The relative position of the cables, laid on the cable tray shall be preserved and the cables shall not cross each other. At all changes in direction in horizontal and vertical planes, the cable shall be bent smooth with a radius as recommended by the manufacturers. All cables shall be laid with minimum one diameter gap and shall be clamped at every metre to the cable tray. Cables shall be tagged for identification with aluminum tag and clamped properly at every 20M. Tags shall be provided at both ends and all changes in directions both sides of wall and floor crossings. All cable shall be identified by embossing on the tag the size of the cable, place of origin and termination.

All cables passing through holes in floor or walls shall be sealed with fire retardant Sealant and shall be painted with fire retardant paint upto one meter on all joints, terminations and both sides of the wall crossings by “VIPER CABLE RETARD”.

3.10.2 LAYING OF CABLES IN GROUND

The width of trench for laying single cable shall be minimum 350 mm. Where more than one cable is to be laid in horizontal formation, the width of the trench shall be workout by providing 200 mm gap between the cables, except where otherwise specified. There shall be clearance of 150 mm between the end cable and the side wall of the trench. The minimum depth of the cable trench shall not be less than 750 mm for single layer of

cables. When the cables are laid in more than one tier the depth of the trench shall be increased by 300 mm for each additional tier.

Excavation of trenches: The trenches shall be excavated in reasonably straight lines. Wherever there is a change in direction, suitable curvature shall be provided. Where gradients and changes in depth are unavoidable, these shall be gradual. The excavated soil shall be stacked firmly by the side of the trench such that it may not fall back into the trench. The bottom of the trench shall be levelled and shall be made free from stone, brick bats etc. The trench shall then be provided with a layer of clean, dry sand cushion of not less than 100 mm in depth. Prior to laying of cables, the cores shall be tested for continuity and insulation resistance. The cable drum shall be properly mounted on jacks, at a suitable location, making sure that the spindle, jack etc. are strong enough to carry the weight of the drum and the spindle is horizontal. Cable shall be pulled over rollers in the trench steadily and uniformly without jerks and strains. The entire drum length shall be laid in one stretch. However, where this is not possible the remainder of the cable shall be removed by `Flaking' i.e. by making one long loop in the reverse direction. After the cable has been uncoiled and laid into the trench over the rollers, the cable shall be lifted off the rollers beginning from one end by helpers standing about 10 meters apart and laid in a reasonably straight line. Cable laid in trenches in a single tier formation shall have a cover of clean, dry sand of not less than 150 mm. above the base cushion of sand before the protective cover is laid. In the case of vertical multi-tier formation after the first cable has been laid, a sand cushion of 300 mm shall be provided over the initial bed before the second tier is laid. Finally the cables shall be protected by second class bricks before back filling the trench. The buried depth of uppermost layer of cable shall not be less than 750mm.

Back Filling: The trenches shall be back filled with excavated earth free from stones or other sharp edged debris and shall be rammed and watered, if necessary, in successive layers not exceeding 300 mm. Unless otherwise specified, a crown of earth not less than 50 mm in the centre and tapering towards the sides of the trench shall be left to allow for subsidence.

3.11 CABLES INSIDE BUILDING

Cables inside buildings shall be laid on the cable trays. All cables passing through walls shall run through GI Pipes sleeves of adequate diameter 50 mm apart maintaining the relative position over the entire length.

3.12 ROUTE MARKER

Route marker shall be provided along straight runs of the cables not exceeding 30 meters also for change in the direction of the cable route and underground joints. Route marker shall be of cast iron painted with aluminum paint. The size of marker shall be 100 mm dia with "Cable" and voltage grade inscribed on it.

3.13 CABLE TRAYS

Cable Trays shall be Galvanized and factory fabricated out of MS channels, angle iron, tee, bends, sections, flats and perforated sheet for different loads and number and size of cables as given below :

Cable trays shall be galvanized as per Specification given elsewhere.

a. 1500 mm wide
Runners 25 x 100 x 25 x 3 mm
Rungs 2# 20 x 40 x 20 x 3 mm 250 mm C/C
Suspenders 2 Nos. 40 x 40 x 5 mm GI angle 1500 mm C/C with base support of 40x 40 x 5mm GI angle.

b. 1200 mm wide
Runners 25 x 100 x 25 x 3 mm
Rungs 2# 20 x 40 x 20 x 3 mm 250 mm C/C
Suspenders 2 Nos. 40 x 40 x 5 mm GI angle 1500 mm C/C with base support of 40x 40 x 5mm GI angle.

c. 1000 mm wide
Runners 25 x 100 x 25 x 3 mm
Rungs 2# 20 x 40 x 20 x 3 mm 250 mm C/C
Suspenders 2 Nos. 40 x 40 x 5 mm GI angle 1500 mm C/C with base support of 40x 40 x 5mm GI angle.

d. 750 mm wide
Runners 20 x 75 x 20 x 2.5 mm
Rungs 20 x 30 x 20 x 2.5 mm 250 mm C/C
Suspenders 2 Nos. 32 x 32 x 5 mm GI angle 1800 mm C/C with base support of 40x 40 x 5mm GI angle.

e. 600 mm wide
Runners 20 x 75 x 20 x 2.5 mm
Rungs 20 x 30 x 20 x 2.5 mm 250 mm C/C
Suspenders 2 Nos. 32 x 32 x 5 mm GI angle 1800 mm C/C with base support of 40x 40 x 5mm GI angle.

f. 450 mm wide
Runners 20 x 75 x 20 x 2.5 mm
Rungs 20 x 30 x 20 x 2.5 mm 250 mm C/C
Suspenders 2 Nos. 25 x 25 x 4 mm GI angle 1800 mm C/C with base support of 40x 40 x 5mm GI angle.

g. Supply and fixing of perforated type cable trays of the following sizes of pre-galvanized iron.
600 x 40 x 40 x 2 mm thick
450 x 40 x 40 x 2 mm thick
300 x 40 x 40 x 2 mm thick
150 x 40 x 40 x 2 mm thick

Note : *Suitable length of 10 mm dia GI rod suspenders at 1800 mm interval shall be included in the item for perforated type cable tray.*

3.14 **SPECIFICATION FOR HOT DIP GALVANIZING PROCESS FOR MILD STEEL USED FOR EARTHING, CABLE TRAYS OR JUNCTION BOXES FOR ELECTRICAL INSTALLATION**

General Requirements

I. Quality of Zinc

Zinc to be used shall conform to minimum Zn 98 grade as per requirement of IS:209-1992.

II. Coating Requirement

Minimum weight of zinc coating for mild steel flats with thickness upto 6 mm in accordance with IS:6745-1972 shall be 400 g/sqm.

The weight of coating expressed in grams per square metre shall be calculated by dividing the total weight of Zinc by total area (both sides) of the coated surface.

The Zinc coating shall be uniform, smooth and free from imperfections as flux, ash and dross inclusions, bare patches black spots, pimples, lumpiness, runs, rust stains bulky white deposits, blisters.

Mild steel flats / wires shall undergo a process of degreasing pickling in acid, cold rinsing and then galvanizing.

3.15 **TESTING OF CABLES**

Cables shall be tested at works for all routine tests as per IS including the following tests before being dispatched to site by the project team.

a. Insulation Resistance Test.
b. Continuity resistance test.
c. Sheathing continuity test.
d. Earth test.(in armoured cables)
e Hi Pot Test.

Test shall also be conducted at site for insulation between phases and between phase and earth for each length of cable, before and after jointing. On completion of cable laying work, the following tests shall be conducted in the presence of the Owner's site representative.

a. Insulation Resistance Test(Sectional and overall)
b. Continuity resistance test.
c. Sheathing continuity test.
d. Earth test.

All tests shall be carried out in accordance with relevant Standard Code of Practice and Electricity Rules. The Contractor shall provide necessary instruments, equipment and labour for conducting the above tests and shall bear all expenses in connection with such tests. All tests shall be carried out in the presence of the Owner's site representative, results will be noted and signed by all present and record be maintained.

4 A. DISTRIBUTION PANELS/BOARDS

Main Distribution Panels, Sub-Distribution Panels and Final Distribution shall be covered under this section. Panels/Boards shall be suitable for operation on 3 Phase/single phase, 415/240 volts, 50 cycles, 4 wire system with neutral grounded at transformer. All Distribution panels shall be CPRI tested design and manufactured by a approved manufacturer. **CPRI certificate shall be made available.**

Distribution panels shall comply with the latest Relevant Indian Standards and Electricity Rules and Regulations and shall be as per IS-13947-1993.

4.1 CONSTRUCTION FEATURES

Distribution panels shall be 2 mm thick sheet steel cabinet for indoor installation, dead front, floor mounting/wall mounting type and shall be form 3b construction. The Distribution panels shall be totally enclosed, completely dust and vermin proof and shall be with hinged doors and folded covers, Neoprene gasket, padlocking arrangement and bolted back. All removable/ hinged doors and covers shall be grounded by flexible standard connectors. Distribution panel shall be suitable for the climatic conditions as specified in Special Conditions. Steel sheets used in the construction of Distribution panels shall be 2 mm thick and shall be folded and braced as necessary to provide a rigid support for all components. Joints of any kind in sheet metal shall be seam welded, all welding, slag shall be rounded off and welding pits wiped smooth with plumber metal. The general construction shall confirm to IS-8623-1977 (Part-1) for factory built assembled switchgear & control gear for voltage upto and including 1100 V AC.

All panels and covers shall be properly fitted and square with the frame, and holes in the panel correctly positioned. Fixing screws shall enter into holes tapped into an adequate thickness of metal or provided with wing nuts. Self threading screws shall not be used in the construction of Distribution panels. A base channel of 75 mm x 40 mm x 5 mm thick shall be provided at the bottom for floor mounted panels. Minimum **operating** clearance of 275 mm shall be provided between the floor of Distribution panels and the lowest feeder compartment.

Distribution panels shall be of adequate size with a provision of spare switchgear as indicated on the Single Line Diagram. Feeders shall be arranged in multi-tier. Knockout holes of appropriate size and number shall be provided in the Distribution panels in conformity with the location of cable/conduit connections. Removable sheet steel plates shall be provided at the top to make holes for additional cable entry at site if required.

Every cabinet shall be provided with Trifoliate or engraved metal name plates. All panels shall be provided with circuit diagram engraved on PVC sheet. All live accessible connections shall be shrouded and shall be finger touch proof and minimum clearance between phase and earth shall be 20 mm and phase to phase shall be 25 mm.

4.2 BUS BAR CONNECTIONS

Bus bar and interconnections shall be of high conductivity electrolytic grade aluminium / copper as indicated in the bill of quantities complying with requirement of IS : 5082 – 1981 and of rectangular cross section suitable for carrying the rated full

load current and short circuit current and shall be extendable on either side. Bus bars and interconnections shall be insulated with heat shrinkable sleeve of 1.1 KV grade and shall be colour coded. Bus bars shall be supported on glass fiber reinforced thermosetting plastic insulated supports at regular intervals to withstand the force arising from in case of short circuit in the system. All bus bars shall be provided in a separate chamber and all connections shall be done by bolting. Additional cross sectional area to be added to the bus bar to compensate for the holes. All connections between bus bars and breakers shall be through solid copper / aluminium strips of proper size to carry full rated current and insulated with insulating sleeves. Maximum current density for the busbars shall be 1A/sq.mm for aluminium and **1.4** A/sq.mm for copper busbars.

Maximum allowable temperature for the Bus bar to be restricted to 85 deg C

4.2.1 TEMPERATURE - RISE LIMIT

Unless otherwise specified, in the case of external surface of enclosures of bus bar compartment which shall be accessible but do not need to be touched during normal operation, an increase in the temperature rise limits of 25° C above ambient temperature shall be permissible for metal surface and of 15° C above ambient temperature for insulating surfaces as per IS 8623(Part-2) 1993.

All main distribution panels and sub distribution panels shall be provided with MCCB of appropriate capacity as per Single Line Diagram. All final Distribution boards shall be provided with Miniature Circuit Breakers. Final Single Phase Distribution boards shall be connected to the incoming supply through double pole MCB units & earth leakage circuit breakers. All wiring for final distribution boards shall be concealed behind 5 mm thick bakelite sheet or M S sheet cover. All Distribution boards shall be completely factory wired, ready for connection. All the terminals shall be of proper current rating and sized to suit individual feeder requirements. Each circuit shall be clearly numbered from left to right to correspond with wiring diagram. All the switches and circuits shall be distinctly marked with a small description of the service installed.

Continuous earth bus sized for prospective fault current shall be provided with arrangement for connecting to station earth at two points. Hinged doors/ frames shall be connected to earth through adequately sized flexible braids.

4.3 **CABLE COMPARTMENTS**

Cable compartment of adequate size shall be provided in the Distribution panels for easy clamping of all incoming and outgoing cables entering from the top/bottom. Adequate supports shall be provided in cable compartment to support cables.

4.4 **AIR CIRCUIT BREAKERS (ACB)**

4.4.1 The ACB shall conform to the requirements of IEC 60947-2 / IS 13947-2 and shall be type tested & certified for compliance to standards from–CPRI, ERDA/ any accredited international lab. The circuit breaker shall be suitable for 415 V $\pm$ 10%, 50 Hz supply system. Air Circuit Breakers shall be with moulded housing flush front, draw out type and shall be provided with a trip free manual operating mechanism or as indicated in drawings and bill of quantities with mechanical "ON" "OFF" "TRIP" indications.

The ACB shall be 3/ 4 pole with modular construction, draw out, manually or electrically operated version as specified. The circuit breakers shall be for continuous rating and service short Circuit Breaking capacity (Ics) shall be as specified on the single line diagram and should be equal to the Ultimate breaking capacity(Icu) and short circuit withstand values(Icw) for 1 sec.

Circuit breakers shall be designed to ‘close' and `trip' without opening the circuit breaker compartment door. The operating handle and the mechanical trip push button shall be at the front of the breakers panel. Inspection of main contacts should be possible without using any tools. The ACB shall be provided with a door interlock. i.e. door should not be open when circuit breaker is closed and breaker should not be closed when door is open.

All current carrying parts shall be silver plated and suitable arcing contacts with proper arc chutes shall be provided to protect the main contacts. The ACB shall have double insulation (Class-II) with moving and fixed contacts totally enclosed for enhanced safety and in accessibility to live parts. All electrical closing breaker shall be with electrical motor wound stored energy spring closing mechanism with mechanical indicator to provide ON/OFF status of the ACB.

The auxiliary contacts blocks shall be so located as to be accessible from the front. The auxiliary contacts in the trip circuits shall close before the main contacts have closed. All other contacts shall close simultaneously with the main contacts. The auxiliary contacts in the trip circuits shall open after the main contacts open. Minimum 4 NO and 4 NC auxiliary contacts shall be provided on each breaker.

Rated insulation voltage shall be 1000 volts AC.

4.4.2 CRADLE

The cradle shall be so designed and constructed as to permit smooth withdrawal and insertion of the breaker into it. The movements shall be free from jerks, easy to operate and shall be on steel balls/rollers and not on flat surfaces.

There shall be 4 distinct and separate position of the circuit breaker on the cradle. Racking Interlock in Connected/Test/Disconnected Position.

Service Position : Main Isolating contacts and control contacts of the breaker are engaged.

Test Position : Main Isolating contacts are isolated but control contacts are still engaged

Isolated Position : Both main isolating and control contacts are isolated.

There shall be provision for locking the breaker in any or all of the first three positions.

The following safety features shall be incorporated :

a. Withdrawal or engagement of Circuit breaker shall not be possible unless it is in open condition.

b. Operation of Circuit breaker shall not be possible unless it is fully in service, test or drawn out position.

c. All modules shall be provided with safety shutters operated automatically by movement of the carriage to cover exposed live parts when the module is withdrawn.

d. All Switchgear module front covers shall have provision for locking.

e. Switchgear operating handles shall be provided with arrangement for locking in 'OFF' position.

4.4.3 PROTECTIONS

The breaker should be equipped with micro-controller based , communicable type release with RS 485 port for communication to offer accurate and versatile protection with complete flexibility and shall offer complete over current protection to the electrical system in the following four zones :

- Long time protection.
- Short time protection with intentional delay.
- Instantaneous protection.
- Ground fault protection.

The protection release shall have following features and settings:

a. True RMS Sensing

The release shall sample the current at the rate of 16 times per cycle to monitor the actual load current waveform flowing in the system and shall monitor the true RMS value of the load current. It shall take into account the effect of harmonics also.

b. Thermal Memory

When the breaker shall reclose after tripping on overload, then the thermal stresses caused by the overload if not dissipated completely, shall get stored in the memory of the release and this thermal memory shall ensure reduced tripping time in case of subsequent overloads. Realistic Hot/Cold curves shall take into account the integrated heating effects to offer closer protection to the system.

c. Defined time-current characteristics :

A variety of pick-up and time delay settings shall be available to define the current thresholds and the delays to be set independently for different protection zones thereby achieving a close-to-ideal protection curve.

d. Trip Indication

Individual fault indication for each type of fault should be provided by LEDs for faster fault diagnosis.

e. Self powered

The release shall draw its power from the main breaker CTs and shall require no external power supply for its operation.

f. Zone Selective Interlocking

The release shall be suitable for communication between breakers to enable zone selective interlocking. This feature shall be provided for both short circuit and ground fault protection zones to offer intelligent discrimination between breakers. This feature enables faster clearance of fault conditions, thereby reducing the thermal and dynamic stresses produced during fault conditions and thus minimises the damage to the system.To implement ZSI manufacturer should supply all related equipment like power supply, wiring etc.

On-Line change of settings should be possible. It should be possible to carry out testing of release without tripping the breaker.

g. The release shall meet the EMI / EMC requirements.

h. The setting range of release shall be generally as follows :

TYPE OF PROTECTION	**SETTING RANGE OF RELEASE**	
	PICK-UP CURRENT	**TIME DELAY**
Long Time	0.4 to 1.0 times I_n (I_r) Steps : 0.4, 0.5, 0.55, 0.60, 0.65, 0.70, 0.75, 0.80, 0.85, 0.90, 0.95, 1.00. Operating Limit : 1.05 to 1.2 times I_r	0.5 to 30 sec at 6 I_r Steps 0.5,1, 2,4, 6, 8,12,18,24 and 30 secs Tolerance : Corresponding to ±10% of current.
Short Time	2 to 10 times I_r Steps : 2,3,4,5,6,7,8,9 & 10 Tolerance : ±10%	20 ms to 600 ms Steps 20,60,100,160,200,260,300 400,500 and 600 ms Tolerance : ±10% or 20ms whichever is higher
Instantaneous	2 to 12 times I_n Steps : 2,3,4,6,8,10,12 Tolerance : ±10%	
Ground Fault	0.2 to 0.6 time I_n Steps : 0.2,0.3,0.4,0.5,0.6 Tolerance : ±10%	100 ms to 400 ms Steps : 100,200,300,400ms Tolerance : $\pm$10% or 20 ms whichever is higher.

All **incomer** ACBs shall have following additional protections other than mentioned above.

- Under and over voltage
- Under and over frequency
- Restricted Earth Fault protection
- Trip Circuit supervision with PS class CT's.
- Undercurrent, (for DG set only)
- Reverse power (for DG set only)
- Phase sequence reversal (for DG set only)
- Load shedding and reconnection thru programmable contacts.
- Release should display the Contact wear indication.

The release should provide local indication of actual %age loading at any instant. The release should be able to communicate on MODBUS RTU protocol using inbuilt RS485 port and shall be integral part of supply with trip unit. Parameters of the Protection Release should be changeable from Release as well as thru communication network. Release should have graphical LCD for display of power parameters. The release of incoming breakers should provide comprehensive metering with the following parameters

- Phase currents (running, avg & max) – All parameters in single window.
- Release should be able to capture short circuit current on which ACB has tripped. The last ten trips and alarms shall be stored in memory with the date & time stamping along with type of fault and alarm. The sensing CT Should be Rogowsky type with measurement precision of 1%.
- Release should be self powered.
- Release should have facility to select different type of IDMTL protection (DT,SIT, VIT, EIT, HVF) for better co-ordination with HT Breaker/Fuse.
- Phase voltages (running, avg & max)
- Energy & power parameters (active, reactive and apparent)
- PF
- Frequency
- Maximum Demand (KVA & KW)
- Total Harmonics distortion

All O/G ACBs shall have following functions.

Protection

- The ACB control unit shall offer the following protection functions as standard:
  Long-time (LT) protection with an adjustable current setting and time delay;

- Short-time (ST) protection with an adjustable pick-up and time delay;
- Instantaneous (INST) protection with an adjustable pick-up and an OFF Position.
- Current and time delay setting shall be indicated in amperes and seconds respectively On a digital display.

- Earth-fault protection with an adjustable pick-up and time delay shall be provided if indicated on the appended single-line diagram.

Measurements

- An ammeter with a digital display shall indicate the true rms values of the currents for each phase.Release shall acknowledge the current & time delay settings done by user on the LCD display.

- LED bargraph shall simultaneously display the load level on the three phases.

- A maximeter shall store in memory and display the maximum current value observed since the last reset. The data shall continue to be stored and displayed even after opening of the circuit breaker.

4.4.4 SAFETY FEATURES

a. The safety shutter shall prevent inadvertent contact with isolating contacts when breaker is withdrawn from the Cradle.
b. It shall not be possible to interchange two circuit breakers of two different thermal ratings. For Draw-out breakers, an arrangement shall be provided to prevent rating mismatch between breaker and cradle.

c. There shall be provision of positive earth connection between fixed and moving portion of the ACB either thru connector plug or sliding solid earth mechanism. Earthing bolts shall be provided on the cradle or body of fixed ACB.
d. The incoming panel accommodating ACB shall be provided with indicating lamps for ON-OFF positions, digital voltmeter and ammeter of size not less than 96 mm x 96 mm, selector switches, MCB for protection circuit and measuring instrument circuits.

e. It shall be possible to bolt the draw out frame not only in connected position but also in TEST and DISCONNECTED position to prevent dislocation due to vibration and shocks.

f. Draw out breakers should not close unless in distinct Service/Test/Isolated positions.

g. The insulation material used shall conform to Glow wire test as per IEC60695.

h. The ACB shall provide in built electrical and mechanical anti-pumping.

j. All EDO ACB`s Shall have Ready to Close Contact to ensure that the ACB gets a command only when it is ready to close for applications of Remote Control, AMF, Synchronization and Auto Source Change Over Systems.

4.5 MOULDED CASE CIRCUIT BREAKER (MCCB)

The MCCB should be current limiting type with trip time of less than 10 msec under short circuit conditions. The MCCB should be either 3 or 4 poles as specified in BOQ. MCCB shall comply with the requirements of the relevant standards IS13947 – Part 2/IEC 60947-2 and should have test certificates for Breaking capacities from independent test authorities CPRI / ERDA or any accredited international lab.

MCCB shall comprise of Quick Make -break switching mechanism, arc extinguishing device and the tripping unit shall be contained in a compact, high strength, heat resistant, flame retardant, insulating moulded case with high withstand capability against thermal and mechanical stresses

The breaking capacity of MCCB shall be as specified in the schedule of quantities. The rated service breaking capacity (Ics) should be equal to rated ultimate breaking capacities (Icu). MCCBs for motor application should be selected in line with Type-2 Co-ordination as per IEC-60947-2, 1989/IS 13947-2. The breaker as supplied with ROM should meet IP54 degree of protection.

4.5.1 CURRENT LIMITING & COORDINATION

The MCCB shall employ maintenance free minimum let-through energies and capable of achieving discrimination up to the full short circuit capacity of the downstream MCCB. **The manufacturer shall provide both the discrimination tables and let-through energy curves for all.**

a. Protection Functions

- MCCBs with ratings up to 200 A shall be equipped with Thermal-magnetic (thermal for overload and magnetic for short-circuit protection) trip units
- Microprocessor MCCBs with ratings 250A and above shall be equipped with microprocessor based trip units.
- Microprocessor and thermal-magnetic trip units shall be adjustable and it shall be possible to fit lead seals to prevent unauthorised access to the settings
- Microprocessor trip units shall comply with appendix F of IEC 60947-2 standard (measurement of rms current values, electromagnetic compatibility, etc.)
- Protection settings shall apply to all poles of circuit breaker.
- All Microprocessor components shall withstand temperatures up to 125 °C

b. Testing

Original test certificate of the MCCB as per IEC 60947-1 &2 or IS13947 shall be furnished. Pre-commissioning tests on the switch board panel incorporating the MCCB shall be done as per standard specifications.

c. Interlocking

Moulded, case circuit breakers shall be provided with the following interlocking devices for interlocking the door of a switch board.

- Handle interlock to prevent unnecessary manipulations of the breaker.
- Door interlock to prevent the door being opened when the breaker is in ON position.
- Defeat-interlocking device to open the door even if the breaker is in ON position.

The MCCB shall be current limiting type and comprise of quick make – Break switching mechanism. MCCBs shall be capable of defined variable overload adjustment. All MCCBs rated 200 Amps and above shall have adjustable over load & short circuit pick-up both in Thermal magnetic and Microprocessor Trip Units.

All MCCB with microprocessor based release unit, the protection shall be adjustable Overload, Short circuit and earth fault protection with time delay.

The trip command shall override all other commands.

4.6 MOTOR PROTECTION CIRCUIT BREAKER (MPCB)

Motor circuit breakers shall conform to the general recommendations of standard IEC 947 -1,2 and 4 (VDE 660, 0113 NF EN 60 947-1-2-4, BS 4752) and to standards UL 508 and CSA C22-2 N°14.

The devices shall be in utilization category A, conforming to IEC 947-2 and AC3 conforming to IEC 947-4.MPCB shall have a rated operational and insulation voltage of 690V AC (50 Hz) and MPCB shall be suitable for isolation conforming to satandrd IEC 60947-2 and shall have a rated impulse withstand voltage (Uimp) of 6 kV. The motor circuit breakers shall be designed to be mounted vertically or horizontally without derating. Power supply shall be from the top or from the bottom. In order to ensure maximum safety, the contacts shall be isolated from other functions such as the operating mechanism, casing, releases, auxiliaries, etc, by high performance thermoplastic chambers. The operating mechanism of the motor circuit breakers must have snap action opening and closing with free tripping of the control devices. All the poles shall close, open, and trip simultaneously. The motor circuit breakers shall accept a padlocking device in the “isolated” position.

The motor circuit breakers shall be equipped with a "PUSH TO TRIP" device on the front enabling the correct operation of the mechanism and poles opening to be checked. The auxiliary contacts shall be front or side mounting, and both arrangements shall be possible. The front-mounting attachments shall not change the breaker surface area. Depending on its mounting direction the single pole contact block could be NO or NC. All the electrical auxiliaries and accessories shall be equipped with terminal blocks and shall be plug-in type. The motor circuit breakers shall have a combination with the downstream contactor enabling the provision of a perfectly co-ordinated motor-starter. This combination shall enable type 1 or type 2 co-ordination of the protective devices conforming to IEC 60947-4-1.Type 2 co-ordination shall be guaranteed by tables tested and certified by an official laboratory: LOVAG (or other official laboratory).The motor circuit breakers, depending on the type, could be equipped with a door-mounted operator which shall allow the device setting. The motor circuit breakers shall be equipped with releases comprising a thermal element assuring overload protection and a magnetic element for short-circuit protection. In order to ensure safety and avoid unwanted tripping, the magnetic trip threshold (fixed) shall be factory set to an average value of 12 Ir.

All the elements of the motor circuit breakers shall be designated to enable operation at an ambient temperature of 60°C without derating. The thermal trips shall be adjustable on the front by a rotary selector. The adjustment of the protection shall be simultaneous for all poles. Phase unbalance and phase loss detection shall be available. Temperature compensation (-20°C to +60°C)

4.7 MINIATURE CIRCUIT BREAKER (MCB)

Miniature Circuit Breaker shall comply with IS-8828-1996/IEC898-1995. Miniature circuit breakers shall be quick make and break type for 240/415 VAC 50 Hz application with magnetic thermal release for over current and short circuit protection. The breaking capacity shall not be less than 10 KA at 415 VAC. MCBs shall be DIN mounted. The MCB shall be Current Limiting type (Class-3). MCBs shall be classified (B,C,D ref IS standard) as per their Tripping Characteristic curves defined by the manufacturer. The MCB shall have the minimum power loss (Watts) per pole defined as per the IS/IEC and the manufacturer shall publish the values. MCB shall ensure complete electrical isolation & downstream circuit or equipment when the MCB is switched OFF.

The housing shall be heat resistant and having a high impact strength. The terminals shall be protected against finger contact to IP20 Degree of protection. All DP, TP, TPN and 4 Pole miniature circuit breakers shall have a common trip bar independent to the external operating handle.

Coordination Study in LV Network

LV Switchgear Manufacturer shall submit coordinated & Discriminated solution for LV Network protection devices i.e. **ACB, MCCB, MPCB &** MCB for all Incoming and outgoing devices for all Panels/ DB`s as per BOQ with the help of published discrimination tables. Total discrimination shall be provided up to the short circuit breaking capacity of most down stream circuit Breakers .

4.8 **RESIDUAL CURRENT CIRCUIT BREAKER CURRENT OPERATED TYPE (RCCB)**

4.8.1 SYSTEM OF OPERATION

Residual Current Circuit Breaker shall confirm to IEC 61008. RCCB shall work on the principle of core balance transformer. The incoming shall pass through the torroidal core transformer. As long as the currents in the phase and neutral shall be the same, no electro motive force shall be generated in the secondary winding of the transformer. In the event of a leakage to earth, an unbalance shall be created which shall cause a current to be generated in the secondary winding, this current shall be fed to a highly sensitive miniature relay, which shall trip the circuit if the earth leakage current exceeds a predetermined critical value. RCCB shall be current operated independent of the line voltage, current sensitivity shall be of 30 mA at 240/415 volts AC and shall have a minimum of 20,000 electrical operations.

4.8.2 MECHANICAL OPERATION

The moving contacts of the phases shall be mounted on a common bridge, actuated by a rugged toggle mechanism. Hence, the closing /opening of all the three phases shall occur simultaneously. This also shall ensure simultaneous opening of all the contacts under tripping conditions.

4.8.3 NEUTRAL ADVANCE FEATURE

The neutral moving contact shall be so mounted on the common bridge that, at the time of closing, the neutral shall make contact First before the phases; and at the time of opening, the neutral shall breaks last after allowing the phases to open first. This is an important safety feature which is also required by regulations.

4.8.4 TESTING PROVISION

A test device shall be incorporated to check the integrity of the earth leakage detection system and the tripping mechanism. When the unit is connected to service, pressing the test knob shall trip the ELCB / RCCB and the operating handle shall move to the "OFF" position.

4.9 **METERING FOR EACH DG**

As mentioned in the Schedule of Quantities.

4.10 **ANNUNCIATION**

Annuciation with Hooter, Test, Accept and Reset P.B. and Annunciator.

16 Window Solid State Annunciator / Power Command Central Module for each DG sets.

Channel No.	**Inscription**
a.	Set fails to start (only alarm)
b.	Over current (breaker trip)
c.	Earth Fault (Breaker trip)

d. Excitation Failure (Engine shall stop with breaker trip)
e. Emergency Shutdown (Breaker will trip with engine stop command)
f. Over speed (Breaker will trip with engine stop command)
g. Low Lube Oil pressure (Breaker will trip with engine stop command)
h. High Water Temperature (Breaker will trip with engine stop command
i. Under Voltage (Breaker trip)
j. Over Voltage (Breaker trip)
l. Bearing Temperature high (breaker will trip with engine stop command)
m. Winding Temperature High Breaker with trip with engine stop command)
n. Low fuel oil level (only alarm at preset level.

4.11 EARTHING

Earthing shall be provided as per IS:3043-1987.

4.12 **PAINTING**

All sheet steel work shall undergo a process of degreasing, pickling in acid, cold rinsing, phosphating, passivaiting (seven tank processing) and then painted with electrostatic paint (Powder coating). The shade of colour of panel inside/outside shall be as per BOQ confirming to IS Code No.5.

4.13 **LABELS**

Engraved PVC labels shall be provided on all incoming and outgoing feeder. Circuit diagram showing the arrangements of the circuit inside the distribution panels shall be pasted on inside of the panel door and covered with transparent plastic sheet.

4.14 **METERS**

i. All voltmeters and indicating lamps shall be through MCB's.

ii. Meters and indicating instruments shall be flush type.

iii. All CT's connection for meters shall be through Test Terminal Block (TTB).

iv. CT ratio and burdens shall be as specified on the Single line diagram.

4.15 **CURRENT TRANSFORMERS**

Current transformers shall be provided for Distribution panels carrying current in excess of 60 amps. All phase shall be provided with current transformers of suitable VA burden with 5 amps secondaries for operation of associated metering.

The CTs shall confirm to relevant Indian Standards. The design and construction shall be dry type, epoxy resin cast robust to withstand thermal and dynamic stresses during

short circuits. Secondary terminals of CTs shall be brought out suitable to a terminal block which shall be easily accessible for testing and terminal connections. The protection CTs shall be of accuracy class 5P10 and measurement CTs shall be of accuracy class I.

4.16 **POTENTIAL FREE CONTACTS**

Potential free contacts shall be provided for connection to Building Automation System in panels indicated in Schedule of Quantities.

4.17 **INDICATING PANEL**

All meters and indicating instruments shall be in accordance with relevant Indian Standards. Meters shall be flush mounted type. Indicating lamps shall be of low burden, and shall be backed up with 2 amps MCB/MPCB as per relevant fault level and toggle switch.

4.18 **TESTING**

Testing of panels shall be as per following codes:

a. IS: 8623 (Part -I) 1977 for factory built assemblies of switch gear for voltages upto and including 1000 VAC.

b. IS: 13947 : 1993 Degree of protection

c. IS: 5578 & 11353:1985 Arrangement of bus bars.

4.19 **WIRING**

In wiring a distribution panel it shall be insured that total load of various distribution panel and/or consuming devices is divided evenly between the phases and number of ways as per Consultants drawing.

4.20 **ANTI-CONDENSATION SPACE HEATERS**

1 No. 100 W, 240 volts, single phase, 50 Hz AC Anti Condensation space heaters controlled by thermostat and protected by 6 amps MCB's or MPCB's as per fault level at the panel shall be provided in each vertical section of main LT panel and 1 No. 60 watt Anti Condensation space heater with thermostat shall be provided in each cable alley of main distribution boards and sub distribution boards.

4.21 INSTALLATION

Installation of all LT panels shall include but not limited to the following to complete the installation, testing and commissioning:

a. Transporting materials from stores to exact location of installation.

b. Supply and installation of required base frame made of MS angle or channel sections and duly painted with black paint.

c. Positioning, aligning, fixing, assembling, and installation of LT panel issued free of cost by Client after carrying out proper cleaning and inspection.

d. Site supervision, testing for proper functioning / operation, and pre-commissioning tests.

4.22 COMMISSIONING AND ON SITE TESTING_

a. All switchboards shall be tested for dielectric test with 1000V megger.

b. All earth connections shall be checked for continuity.

c. All busbar connections shall be checked and tightened properly.

d. All cable terminations and terminal shrouding shall be checked if they are properly done.

e. The operation of protective devices shall be tested by secondary injection test.

f. The operation of circuit breaker shall be tested for all interlocks.

g. Functional test shall be done for all ACBs, MCCBs and other components.

h. Indicating lamps and meters shall be checked for proper working.

4 B. FINAL DISTRIBUTION BOARDS (FDB's)

Final Distribution Boards (FDBs) shall be suitable for operation on 3 Phase/single phase, 415/240 volts, 50 cycles, neutral grounded at transformer. The DB shall be minimum di-electric strength of 2.5 KV / Sec. All Distribution Boards shall manufactured by a manufacturer listed in Appendix-I.

FDB's shall comply with the latest Relevant Indian Standards and Electricity Rules and Regulations and shall be as per IS-13947-1993.

4.1 CONSTRUCTION FEATURES

FDB's shall be made out of 1.6 mm thick high quality CRCA sheet steel and shall be pre-treated and powder coated sheet steel used in the construction of FDB shall be folded and braced as necessary to provide a rigid support for all component. FDB shall be suitable for indoor / outdoor installation, wall mounting free standing type, in double door construction. The Final Distribution Boards shall be totally enclosed, completely dust and vermin proof and shall be with hinged doors, Neoprene gasket, padlocking arrangement. All removable/ hinged doors and covers shall be grounded by 4.0 sqm tinned stranded copper connectors. Final Distribution Boards shall be suitable for the climatic conditions. Joints of any kind in sheet metal shall be seam welded, all welding, slag shall be rounded off and welding pits wiped smooth with plumber metal. The general construction shall confirm to IS-8623-1977 (Part-1) for factory built assembled switchgear & control gear for voltage upto and including 1100 V AC.

All panels and covers shall be properly fitted and square with the frame, and holes in the panel correctly positioned. Fixing screws shall enter into holes tapped into an

adequate thickness of metal or provided with wing nuts. Self threading screws shall not be used in the construction of FDBs.

Knockout holes of appropriate size and number shall be provided in the FDB's in conformity with the location of cable/conduit connections. Detachable sheet steel gland plates shall be provided at the top / bottom to make holes for additional cable entry at site if required.

Final Distribution Boards shall comprises of the following:

4.1.1 A panel for mounting where appropriate incoming supply circuit breaker & other auxiliaries for Control & distribution as required.

4.1.2 Installation accessories shall be part of the DB for fixing conductor and rails for mounting MCB's and RCCB's etc. neutral bus bars & earthing bus bars required in the circuit. All busbars in the FDB shall be insulated type.

4.1.3 Service cable /enterconnection shall be part of the Distribution Boards.

4.1.4 The board shall be installed at a height such that the operating is within reach of the normal human height i.e. 1.2 to 1.8 meters from finish floor level.

4.1.5 Degree of protection shall be IP-52 for indoor application, IP-54 for kitchen and IP-55 for outdoor application.

4.1.6 All three phase distribution boards shall have 4 rows and single phase distribution boards shall have single rows for housing of MCB's and RCCB's unless noted otherwise.

4.1.7 Phase segregation to be maintained in all three phase distribution boards.

4.1.8 Earthing shall be provided in each FDB's.

4.2 MINIATURE CIRCUIT BREAKER (MCB)

For specifications refer Section 4A, clause 4.7

4.3 RESIDUAL CURRENT CIRCUIT BREAKER CURRENT OPERATED TYPE (RCCB)

For specifications refer Section 4A, clause 4.8

4.4 EARTHING

Earthing shall be provided as per IS:3043-1987.

4.5 PAINTING

All sheet steel work shall undergo a process of degreasing, pickling in acid, cold rinsing, phosphating, passivaiting (seven tank processing) and then painted with

electrostatic paint (Powder coating). The shade of colour of panel inside/outside shall be of Siemens gray paint shade no. RAL-7032 of IS Code No.5.

4.6 **LABELS**

Engraved PVC labels shall be provided on all incoming and outgoing feeder. Circuit diagram showing the arrangements of the circuit inside the distribution panels shall be pasted on inside of the panel door and covered with transparent plastic sheet.

4.7 **TESTING**

Testing of panels shall be as per following codes:

a. IS: 8623 (Part -I) 1977 for factory built assemblies of switch gear for voltages upto and including 1000 VAC.

b. IS: 13947 : 1993 Degree of protection

4.8 **WIRING**

In wiring a distribution panel it shall be insured that total load of various distribution panel and/or consuming devices is divided evenly between the phases and number of ways as per Consultants drawing.

5. POWER FACTOR CORRECTION SYSTEM

5.1 POWER FACTOR CORRECTION SYSTEM WITH DETUNED FILTER

5.1.1 SCOPE

Design, manufacture, supply, erection, testing and commissioning of Indoor type power correction capacitor banks for power factor improvement as per specification given below:

5.1.2 STANDARD

Unless otherwise stated below, the capacitor shall comply with the following standards (and their latest amendments): IS 13340-1993, IS 13341-1992, IEC 60831-1+2

5.1.3 RATING

100 KVAR (or less) capacitor units as specified in the BOQ shall be used to form a bank of capacitors of desired capacity.

5.1.4 ENCLOSURE

The panel shall be indoor type, free standing, and floor mounting with IP42 degree of protection. It shall be completely made of CRCA sheet steel. The enclosure shall have sturdy support structure with angle supports as necessary and shall be finished with powder coating in the approved colour shade/s to match the colour of the other panels. The thickness of powder coating should be minimum 60-80 microns.

Suitable provisions shall be made in the panel for proper heat dissipation. Air aspiration louvers for heat dissipation shall be provided as a necessary.

The front portion shall house the switchgear and the rear portion shall house capacitors and series reactors. The enclosure is to be suitably sized to accommodate all the components, providing necessary air clearance between live and non-live parts, providing necessary working clearance.

5.1.5 APFC RELAY / CONTROLLER

Microprocessor based APFC relay (Intelligent VAr controller) shall sense the PF in the system and automatically switch ON / OFF the capacitor unit or stage to achieve the preset target PF. The controller shall have the following features :

- Digital settings of parameters like PF, Switching time delay, Step limit etc.
- Indication of PF, preset parameters.
- Minimum threshold setting of 1% of CT current.
- No-volt release.
- Protective shut down in case of harmonic overload.
- Indication for Failure to achieve the target PF, Harmonic overloading, Step failure etc.

5.1.6 CAPACITOR UNIT

Each basic unit of mixed dielectric extra low loss / All Poly Propylene (APP) capacitor shall be built with a number of elements. These elements shall be combination of capacitor tissue paper and biaxially oriented polypropylene film impregnated with non PCB bio-degradable impregnant or Film Foil capacitor manufactured using Poly propylene film placed between 2 layers of metal foil and winding. The elements shall be connected to the external bus bars through these leads in a series parallel connection to form a three phase unit.

The capacitor units shall be floor mounting type using minimum floor space. The container of capacitors shall be made out of 2 mm thick M S sheet steel of polyster paint coated finish. Each standard unit shall be provided with internal fuses (operation co-ordinated with case-rupture characteristics to avoid rusting).

Total Harmonic Distortion (THD) of upto 5% on voltage and current waveforms shall not affect the life of capacitors. 660±10% variation in line voltage shall not affect the life of the capacitors.

5.1.7 CAPACITORS

- General specifications : 3 phase, delta connected, 50 Hz.
- Voltage : Shall be designed for minimum **520V** and shall withstand system over voltage, increased voltage due to series reactor and harmonics.

- Capacitor type : Super heavy duty with double side metallised capacitor tissue paper. Oil impregnated and self-healing type with bi-axially oriented polypropylene film shall be fitted with pressure sensitive disconnector in each individual capacitor cell.

- Overvoltage +10% (12h / 24h), + 15% (30m / 24h), + 20% (5m), +30% (1m) as per Clause 6.1 of IS 13340-1993.

- Overcurrent : 2.5 x In

- Peak Inrush current withstand : 350 x In

- Total watt-losses including discharge resistors : $\leq$ 0.45 W / k V Ar.

- Temperature category : -25 deg.C to 70 deg.C.

- Capacitor shall be self-heating type and oil impregnated for longer life. The impregnant shall be non-PCB, biodegradable type, must be properly treated and de-gasified, so as not to have any degeneration properties and shall be non-oxidizing.

- The design shall be modular for simple mechanical assembly, no extra accessories / metal parts to be required. Unit must be free standing with an IP 41 protection level.

5.1.8 DISCHARGE RESISTANCE

Capacitors shall be provided with permanently connected discharge resistors so that residual voltage of capacitors is reduced to 50 volts or less within one minute after the capacitors are disconnected from the source of supply.

5.1.9 TERMINALS

Each capacitor bank shall be provided with a terminal chamber and cable glands suitable for PVC insulated aluminum conductor armoured cables as specified.

5.1.10 EARTHING

Two separate earthing terminals shall be provided for earth connection of each bank.

5.1.11 LOW VOLTAGE FILTER REACTOR

Filter reactor shall be series type having a three phase, iron core construction suitable for indoor use. The reactor shall be air cooled and the layout shall be in accordance with IEC 76. The complete unit shall be impregnated under vacuum and over-pressure in impregnation resin and shall be suitable for temperature class H operation. The reactor coils shall be wound with high grade aluminum / copper and termination shall be provided with suitably designed copper bars.

5.1.12 TESTING

The reactor shall be tested `using a separate source voltage test of 3 KV (coil to core) for one minute as per IEC 76/3. The reactor shall be fitted with a temperature sensitive micro-switch in the centre coil (normally open) for connection to trip circuit in case of high operating temperature.

5.1.13 SERIES REACTOR

Application

LV Harmonic Filters shall be used with harmonic filter duty power capacitors to mitigate harmonics, improve power factor and avoid electrical reasonance in LV electrical networks.

Construction, Testing & Protection

The low voltage filter reactor shall be series type having a three phase, iron core construction suitable for indoor use . The reactor shall be air cooled and the layout shall be in accordance with IEC 60076.

The complete unit shall be impregnated under vacuum and over-pressure in impregnation resin and shall be suitable for temperature Class H (T60/H) operation.

The reactor shall be tested using a separate source voltage test of 3.0kV (coil to core) for 1 minute as per IEC 60076/3.

The permitted tolerance of inductance shall be + 3% of rated inductance value.

Reactor tuning factor shall be 7% and the current rating of the reactor shall include the effects of harmonics and other possible over-currents.

The limit of linearity of inductance of the filter reactor shall be as follows $1.2 \bullet \sum I\eta$ with $L = 0.95\ L_N$

The reactor shall be fitted with a temperature sensitive micro-switch in the centre coil (normally open) for connection to trip circuits in case of high operating temperatures.

5.1.14 SWITCHGEAR & PROTECTION

Incomer switchgear shall be TP&N breaker appropriate rating (**minimum 1.8 times** the normal current to take care of inrush switching current). Suitable contactor for each step shall be used and must be capable of capacitor switching duty at each step for short circuit protection.

Busbars shall be suitably colour coded and must be mounted on appropriate insulator supports.

Power cables used shall have superior mechanical, electrical and thermal properties, and shall have the capability to continuously operate at very high temperatures upto 125 deg.C.

Internal wiring between main bus-bars, breaker, contactor and capacitors shall be made with 1100 V grade, PVC insulated, copper conductor cable of appropriate size, by using suitable copper crimping terminal ends etc.

Suitable bus links for input supply cable termination shall be provided.

5.1.15 CONTROL CIRCUIT & GENERAL PROTECTION

The control circuit shall be duly protected by using suitable rating MCB.

An emergency stop push button shall be provided to trip the entire system (22.5 mm dia, mushroom type, press to stop and turn to reset).

Wiring of the control circuit shall be done by using 1.5 sq.mm, 1100 V grade, PVC insulated, multi-stranded copper control wire.

Inspection terminal strip, number ferruling, labeling etc. shall be provided.

440 V caution board on the panel shall be provided.

5.1.16 TESTING

The capacitor bank shall be subject to tests as specified in relevant Indian Standards at the factory and the test certificates shall be furnished in quadruplicate.

5.1.17 INSTALLATION

i. Capacitors banks shall be installed as per installation manual of supplier and shall conform to relevant Indian Standards.

ii. All interconnections in the control panel shall be checked before commissioning.

iii. Cable end boxes shall be sealed after cable connections to prevent absorption of moisture.

iv. 15 mm thick rubber matting of an approved make over a 100 mm high Timber platform shall be provided in front of the full length of the capacitor bank and control panel.

5.1.18 TESTING & COMMISSIONING

i. Insulation resistance shall be tested with a 1000 volts meagger between phases and phase to earth.

ii. Residual voltage shall be measured after switching of the capacitors and the same shall not be more than 50 volts after one minute.

iii. Each discharge resistor shall be tested for its working.

6. EARTHING

6.1 EARTHING

The system shall be TNS with four wire supply system (R,Y,B,N and 2 Nos. E) brought from the main L T Panel. All the non-current carrying metal parts of electrical installation and all metal conduits trunking, cable sheaths, switchgear, distribution

panels, light fittings and all other parts made of metal shall be bonded together and connected by means of specified earthing conductors to an efficient earthing system. All metal work such as pipe lines, ducts, cable trays, stair case railing etc shall be bonded to earth.

All earthing shall be in conformity with IS:3043 1987, and the basic system of earthing shall be TNS.

6.2 EARTHING CONDUCTORS

Earthing conductors shall be of copper / GI as mentioned in schedule of quantities and shall be protected against mechanical injury and corrosion.

6.3 SIZING OF EARTHING CONDUCTORS

The cross sectional area of earthing conductor shall not be smaller than half of the largest current carrying conductor subject to an upper limit of 80 Sq.mm. If the area of the largest current carrying conductor or bus bar exceeds 160 sq.mm then two or more earthing conductors shall be used in parallel, to provide at least half the cross sectional area of the current carrying conductor or bus bars. All fixtures, outlet boxes, junction boxes and power circuits upto 15 amps shall be earthed with PVC insulated copper wire.

6.4 CONNECTION OF EARTHING CONDUCTORS

Main earthing conductors shall be taken from the earth connections at the main L T panel to an earth electrode with which the connection is to be made. All joints in tapes shall be with four rivets and shall be brazed in case of copper and by welding bolting in case of GI, wires shall be connected with crimping lugs, all bolts shall have spring washers. Sub- mains earthing conductors shall run from the main distribution panel to the sub distribution panel. Final distribution panel earthing conductors shall run from sub-distribution panel.

Circuit earthing conductor shall run from the exposed metal of equipment and shall be connected to any point on the main earthing conductor, or its distribution panel. Metal conduits, cable sheathing and armouring shall be earthed at the ends adjacent to distribution panel at which they originate, or otherwise at the commencement of the run by an earthing conductor in effective electrical contact with cable sheathing. Where equipment is connected by flexible cord, all exposed metal parts of the equipment shall be earthed by means of an earthing conductor enclosed with the current carrying conductors within the flexible cord Switches, accessories, lighting fitting etc. which are rigidly secured in effective electrical contact with a run of metallic conduit shall not be considered as a part of the earthing conductor for earthing purposes, even though the run of metallic conduit is earthed. The installation shall be complete in all respects for efficient and trouble free service. All work shall be carried out in a first class quality and neat workmanship. Grounding conductors shall be handled carefully to avoid kinking and cutting of the conductors during their installation. All exposed ground conductors run shall be taken in a neat manner horizontal, vertical and parallel to the building walls or columns and shall not be laid haphazardly. All connections to the grounding grid shall be made with **earthing** strip welded to grid and bolted at equipment ends.

6.5 **PROHIBITED CONNECTIONS**

Neutral conductor, sprinkler pipes, or pipes conveying gas, water or inflammable liquid, structural steel work, metallic enclosures, metallic conduits and lightning protection system conductors shall not be used as a means of earthing an installation or even as a link in an earthing system. The electrical resistance measured between earth connection at the main LT panel and any other point on the completed installation shall be low enough to permit the passage of current necessary to operate or circuit breakers, and shall not exceed 1ohm. All switches carrying medium voltage shall be connected with earth by two separate and distinct connections. The earthing conductors inside the building wherever exposed shall be properly protected from mechanical injury by running the same in G I pipe of adequate size. The overlapping in strips at joints where required shall be minimum 75 mm. The joints shall be riveted and brazed in case of copper and by welding / bolting in case of GI in an approved manner. Sweated lugs of adequate capacity and size shall be used for termination of all conductor wires above 6 sq.mm size. Lugs shall be bolted to the equipment body to be earthed after the metal body is cleaned of paint and other oily substances and properly tinned. Equipotential bonding of all metallic structures shall be done.

6.6 **EARTHING**

The following must always be ensured in earthing system.

- All earths must be interconnected at the earth pits. This includes generator neutrals, transformer neutrals, transformer body, lightning protection system earths, UPS earths etc.

- Extraneous conductive parts such as gas pipes, other service pipes and ducting risers and pipes of fire protection equipment and exposed metalic parts of the building structure.

6.7 The Contractor shall get the soil resistivity test done at his own cost of the area where earthing pits are to be located before starting the installation.

6.8 **RESISTANCE TO EARTH**

The resistance of earthing system shall not exceed 1 ohm.

6.9 **SPECIFICATION FOR HOT DIP GALVANIZING PROCESS FOR MILD STEEL USED FOR EARTHING FOR ELECTRICAL INSTALLATION**

General Requirements

I. Quality of Zinc

Zinc to be used shall conform to minimum Zn 98 grade as per requirement of IS:209-1992.

II. Coating Requirement

Minimum weight of zinc coating for mild steel flats with thickness upto 6 mm in accordance with IS:6745-1972 shall be 400 g/sqm.

The weight of coating expressed in grams per square metre shall be calculated by dividing the total weight of Zinc by total area (both sides) of the coated surface.

The Zinc coating shall be uniform, smooth and free from imperfections as flux, ash and dross inclusions, bare patches black spots, pimples, lumpiness, runs, rust stains bulky white deposits, blisters.

Mild steel flats / wires shall undergo a process of degreasing pickling in acid, cold rinsing and then galvanizing. Jointing of earthing tape shall be by welding. All joints and cut ends shall be properly painted with aluminium paint.

7. LIGHTNING PROTECTION SYSTEM

7.1 LIGHTENING PROTECTION SYSTEM ESE ADVANCED LIGHTNING PROTECTION SYSTEM (Based on NFC17-102)

7.1.1 SCOPE OF WORK

The work to be done under this section comprises the supply & installation necessary for the complete installation of the lightning protection system.

The design of the components shall be traceable to field research, laboratory testing, fundamental analysis, and statistical levels of the lightning event.

The design of the components shall be traceable to long term practical field studies laboratory testing, fundamental scientific principles and statistical levels of the lightning event as documented in international standard.

The lightning protection system should complies in accordance with NFC 17-102 standard and shall be installed strictly to the manufacturer's instructions.

The advanced lightning protection system shall include components as follows:
ESE Air terminal
Mechanical supports
Down-conductors
Performance Recording Equipment
A low impedance Grounding system.

7.1.2 STANDARDS

Complete installation shall be engineering and constructed in accordance with the latest revision of the following :

- NFC-17-102
- IEC 61204

The details of the lightning protection system shall also confirm to the requirements of all relevant local codes, as applicable, together with the additional requirements referred

to in this specification and drawings, whichever is more stringent and acceptable to the engineer.

7.1.3 AIR TERMINAL

The air termination shall be of the type that responds dynamically to the appearance of a lightning downleader by creating free electrons between outer surfaces and an earthed central finial rod.

The Airterminal should work under **Early Streamer Emission (ESE) Technology** and the attractive radius of the air termination shall be traceable to known and acceptable lightning research and statistics.

The Lightning conductor should deliver a unique gain time in efficiency, anticipating the natural formation of an upward leader. The Airterminal generates a leader that propagates rapidly to capture the Lighting stroke and conduct it towards the ground.

Arcing is not to be continuous and shall only occur during the progress of the lightning leader.

The air termination shall not cause high frequency radio interference except during the millisecond intervals associated with the progress of the lightning leader and during the main return strike of lightning events in the region.

The materials of the air termination shall be non-corroding in normal atmosphere.

The air termination shall not be dependent upon batteries or external power supplies for any part of its operation.

The Height of the air terminal support mast should be minimum 2mts and the height will be increased as per the coverage design.

The support shall be securely installed and guy wires shall be used where necessary to enable the air termination and mast system to withstand maximum locally recorded wind velocities.

7.1.4 DOWN CONDUCTOR

The down conductor should be single core 70 sq mm insulated unarmored cable connected with maintenance-free Grounding system.

The main copper conductor shall be connected directly to the air termination.

The down conductor shall be installed in accordance with the manufacturer’s instructions and should not be subject to sharper bends.

The down conductor must be kept in constant physical contact with the structure via conductive mounting clamps.

7.1.5 LIGHTNING FLASH COUNTER

Each protection system shall be supplied with Lightning strike counter. The counter shall have a register that activates one count for every discharge where the peak current exceeds 400A at the 8/20us standard.

The lightning flash counter shall be robust and easy to install. The counter shall operate from the energy of the lightning discharge and should not work on external or battery power to operate.

The lightning flash counter shall be installed to the manufacturer's instructions in a readily accessible manner (always 2mts above the Ground) so that reading can be taken at regular intervals. It shall be positioned such that its operating temperature is within the range -20'C to + 60'C.

7.1.6 GROUNDING SYSTEM

The Lightning arrestor grounding system reading shall not exceed 10 ohms static impedance except with prior approval by the specifying engineer or manufacturer of the lightning protection system.

Grounding will be done by copper bonded steel core ground rods especially designed for electrical grounding.

Bonding of the grounding system to metallic parts of the building, the structural reinforcing steel of the building to arriving services is recommended.

Electrically conductive, non soluble TEREC Powder should be used to achieve low ground resistance. Provided the materials are mixed and installed strictly in accordance with the manufacturer's instructions.

8. EXTERNAL / STREET LIGHTING POLES

8.1 M.S. TUBULAR POLES

8.1.1 7 METER HIGH POLE WITH LADDER BARS

7 meter high (5.75 meters above and 1.25 meters below ground shall be M.S.step tubular pole in 3 steps (bottom part shall be 4 meters high, 114.3 mm outer dia and 3.65 mm walll thickness, middle part shall be 1.5 meter high, 88.9 mm outer dia and 3.25 mm wall thickness, top part shall be 1.5 meters high, 76.1 mm outer dia and 3.25 mm wall thickness) with 300 mm x 300 mm x 6 mm thick base plate. Foundation for the pole shall be of cement concrete in 1:2:4 ratio (1 part cement, 2 parts, coarse sand and 4 parts stone aggregate) IP-55 weather proof junction box shall also be provided to accommodate 1 No. 3 phase and neutral terminal block and 1 No. 6 amps SP MCB including 2.5 sq.mm PVC insulated copper conductor wire from the terminals block to the fixture and 2 No. 32 mm dia GI sleeves of suitable length shall be provided to the junction box.

8.1.2 4.5 METER HIGH POLE

4.5 meter high (3.6 meter above and 0.9 meter below ground) shall be 75 mm dia, 3.25 mm wall thickness MS tubular straight pole with a cast aluminium adaptor for post top mounting. Pole shall be provided with 300 mm x 300 mm x 6 mm thick MS base

plate. Foundation for the pole shall be of cement concrete in 1:2:4 rates (1 part cement, 2 parts coarse sand and 4 parts stone aggregate) IP-55 weather proof junction box shall also be provided to accommodate 1 No. 3 phase and neutral terminal block and 1 No. 6 amps SP MCB including 2.5 sq.mm PVC insulated copper conductor wires from the terminal block to the fixture and 2 Nos. 32 mm dia GI sleeves of suitable length shall be provided to the junction box.

8.2 **CAST ALUMINIUM POLES**

8.2.1 DESIGN & CONSTRUCTION

Ornamental cast aluminum pole shall be made out of cast aluminum as per requirements of IS:202 (1993). Casting of all pole Sections shall be accurately done from permanent moulds and cores of the design submitted to Achieve uniformity in all design aspects in internal and external shape of the unit. All sections shall be free from defects like blow holes, porosity, hard spots, cracks, Hot tears, cold shuts, distortion, sand and slag inclusion and other harmful defects. All the casted sections used in the pole shall be free from welding of any kind used to repair it. The casted sections shall be machined from all the locations used to insert the pieces into one another using either threading or socket method. Accuracy of all machined parts shall be maintained through out a lot for random replacements of sections if and when required. All the threaded joints shall be mechanically tightened and sealed using industrial tools to make the entire unit vandal resistant.

8.2.2 AESTHETIC APPEARANCE

All the grooves and carvings of the pole unit shall be free from any kind of distortion for a pleasing aesthetic appearance.

8.2.3 MATERIAL

Cast aluminum material used for casting pole unit shall be Grade FG-220 type, as described in IS:202 and shall have minimum tensile strength of the order of 200 N/mmsq.

8.2.4 PRE-TREATMENT

Each and every casted piece shall be subject to Sand blasting at a pressure of 10-15 kgf to remove all its external dirt and sand remains etc..

8.2.5 PAINTING AND FINISHING

Entire unit shall be given an extensive three stage treatment with PU based two packZn-Ph primer and paint prescribed for CI surfaces to make it absolutely rust and corrosion proof, as well as giving it a pleasing appearance. PU based paint shall be MRF make or equivalent.

8.2.6 THICKNESS OF THE COATING

A minimum of 80 microns of coating thickness shall be achieved on the final piece.

8.2.7 MOUNTING ARRANGEMENT

Pole unit shall be grouted using 4 nos. anchor bolts of size M-16x450 mm confirming to 6.8 Gr. as per IS 2062. Pole unit shall be grouted on a foundation made out of 1:3:6 concrete cement after excavating the earth with proper cable sleeves etc.. laid in the foundation itself.

8.2.8 DIMENSIONS OF THE UNIT

Total height =3000 mm

Dia of base plate =380 mm

Pitch Circle Dia =335 mm

8.2.9 DESCRIPTION OF TOP BRACKET / ARMS

Single double decorative arm shall be provided on the pole (as asked for in B.O.Q.), secured with the help of two nos. bolts outreach not less than 400 mm.

8.2.10 SERVICE WINDOW

A service window of the size 150 mm x 100 mm shall be provided in the base of the pole to allow access to electrical connections and terminations. It shall be covered with MS plate and proper rubber gaskets shall be provided to prevent any ingress of water etc..

8.2.11 ELECTRICAL CONNECTIONS

Four way connectors shall be provided along with Slide lock and 1 no. 6 amps Sp MCB including 2.5 sqmm PVC insulated copper conducter wires from the terminal block to the fixture and 2 nos. 32 mm dia GI sleeves of suitable length shall be provided upto the service window. An earth boss is provided on the control plate along with connectors and interrupters.

8.3 **GALVANIZED OCTAGONAL POLES**

8.3.1 DESIGN

The Octagonal poles shall be designed to withstand the maximum wind speed of 169 KM / Hr. as per IS 875. The top loading i.e. area and the weight of fixtures are to be considered to calculate maximum deflection of the pole and the same shall meet the requirement of BS : 5649 Part VI 1982.

8.3.2 POLE SHAFT

The pole shaft shall have octagonal cross section and shall be continuously tapered with single longitudinal welding. There shall not be any circumferential welding. The welding of pole shaft shall be done by submerged Arc Welding (SAW) process.

All octagonal pole shafts shall be provided with the rigid flange plate of suitable thickness with provision for fixing 4 foundation bolts. This base plate shall be fillet

welded to the pole shaft at two locations i.e. from inside and outside. The welding shall be done as per qualified MMAW process approved by Third Party Inspection agency.

8.3.3 DOOR OPENING

The octagonal poles shall have door of approximate 500 mm length at the elevation of 500 mm from the Base plate. The door shall be vandal resistance and shall be weather proof to ensure safety of inside connections. The door shall be flush with the exterior surface and shall have suitable locking arrangement. There shall also be suitable arrangement for the purpose of earthing.

The pole shall be adequately strengthened at the location of the door to compensate for the loss in section.

8.3.4 MATERIAL

Octagonal Poles HT Steel Conforming to grade S355JO

Base Plate Fe 410 conforming to IS 226 / IS 2062

Foundation Bolts EN.8 grade

Welding

The welding shall be carried out confirming to approved procedures duly qualified by third party inspection agency. The welders shall also be qualified for welding the octagonal shafts.

8.3.5 POLE SECTIONS

The Octagonal Poles shall be in single section (upto 11 mtr). There shall not be any circumferential weld joint.

8.3.6 GALVANIZATION

The poles shall be hot dip galvanized as per IS 2629 / IS 2633 / IS 4759 standards with average coating thickness of 70 micron. The galvanizing shall be done in single dipping.

8.3.7 XING TYPE

The Octagonal Poles shall be bolted on a pre-cast foundation with a set of four foundation bolts for greater rigidity.

8.3.8 TOP MOUNTINGS

The galvanized mounting bracket shall be supplied along with the Octagonal Poles for Installation of the luminaries.

8.3.9 MANUFACTURING

The pole manufacturing & galvanizing unit shall be ISO 9001 : 2000 & ISO 14001 certified to ensure consistent quality & environmental protection.

8.3.10 SERVICE WINDOW

A service window of the size 150 mm x 100 mm shall be provided in the base of the pole to allow access to electrical connections and terminations. It shall be covered with MS plate and proper rubber gaskets shall be provided to prevent any ingress of water etc..

8.3.11 ELECTRICAL CONNECTIONS

Four way connectors shall be provided along with Slide lock and 1 no. 6 amps SP MCB including 2.5 sqmm PVC insulated copper conductor wires from the terminal block to the fixture and 2 nos. 32 mm dia GI sleeves of suitable length shall be provided upto the service window. An earth boss is provided on the control plate along with connectors and interrupters.

8.3.12 GALVANIZED OCTAGONAL POLES DIMENSIONS

Height	Top Dia (A/F)	Bottom Dia (A/F)	Sheet Thick Ness	Base Plate Dimensions (LxBxT)	Foundation Bolt			
					Bolt Size (No. x Dia)	Pitch Circle Dia (PCD)	Bolt Length (MM)	Projected Bolt Length
(Mtr)	(mm)	(mm)	(mm)	(mm)	(mm)	(mm)	(mm)	(mm)
3	70	130	3	200 x 200 x 12	4 x 16 Dia	200	450	80
4	70	130	3	200 x 200 x 12	4 x 16 Dia	200	450	80
5	70	130	3	200 x 200 x 12	4 x 16 Dia	200	600	80
6	70	130	3	220 x 220 x 12	4 x 20 Dia	205	600	100
7	70	130	3	220 x 220 x 12	4 x 20 Dia	205	700	100
8	70	135	3	225 x 225 x 16	4 x 20 Dia	210	750	100
9	70	155	3	260 x 260 x 16	4 x 24 Dia	250	750	125
10	70	175	3	275 x 275 x 16	4 x 24 Dia	270	750	125
11	90	210	3	300 x 300 x 20	4 x 24 Dia	300	750	125
12	90	240	3	320 x 320 x 20	4 x 24 Dia	325	850	125

9. DRY TYPE /OIL TYPE CAST RESIN TRANSFORMERS WITH OFF CIRCUIT TAP CHANGING LINK

Scope

Design, manufacture, testing, supplying and commissioning of 33 KV/433 volts step down, transformer complete with all the accessories and fittings for efficient and trouble free operation.

Codes and Standard

Transformer shall Conform to Indian Standard IS:2026-1977 (Part I to IV),IS : 11171 - 1985 IEC 60726, ECBC-2007(Revised in May 2008).

Rating

Transformer shall be suitable for continuous operation and maximum rating shall be as given in the schedule of quantities.

Connections and Vector Group

Delta on High Voltage side and star on low voltage side with neutral terminal brought out for solid earthing corresponding to the Vector Symbol Dyn - 11.

System of Supply

3 phase, 50 Cycles, 33 KV earthed system.

Tappings

Off circuit tap changing links on HV side. The tappings to be provided for variation on HV side from +5% to -7.5% in steps of 2.5 % each.

Temperature Rise

Continuously rated for full load, temperature rise not exceeding 90^{o} C corresponding to Class “F".

Type

Indoor /Outdoor type.

Terminals

The cable box with glands on H T side shall be suitable for 3 core XLPE cable of specified capacity. Flanges with cable box / bus duct on LT side shall be suitable for aluminium conductor armoured cables / LT bus duct of size mentioned in BOQ. All cable glands shall be earthed.

Cooling

A N Cooled

Insulation

Glass fibre reinforced epoxy cast resin type and class `F'.

Earthing

Two earthing terminals shall be provided at the bottom on both sides.

Fittings and Accessories

The following fittings and accessories shall be provided.

a. Transformer shall be provided with 4 Nos bi-directional rollers fitted on cross channels to facilitate the movement of the transformer in both direction.

b. Lifting lugs

c. Diagram and rating plate shall be provided indicating the details of transformer, connection diagram, Vector group, tap changing diagram etc.

d. 6 channels temperature scaner with alarm and trip contacts, and Thermistors

e. HV Cable terminating facility for XLPE cable.

f. LV Cable terminating facility /bus duct termination flange.

Iron Core

The core shall consist of grain oriented laminations which shall be insulated on both sides for low losses.

Winding

High Voltage and Low Voltage windings shall be made of copper and insulation shall be of class F. High voltage and low voltage windings, shall be completely impregnated and cast under vacuum into moulds. This process shall form the insulation system of uniform glass fibre epoxy laminate of highest electrical and mechanical quality, into which windings shall be voidlessly embedded.

Both the high voltage and low voltage windings of each phase shall be separately cast as one rigid tubular coil.

Enclosure

The transformer shall be housed in 2 mm thick CRCA sheet steel enclosure mounted on bi-directional rollers. Enclosure shall be provided with metal screen at top and bottom for ventilation. Degree of protection of enclosure shall be IP-28. Transformer enclosure/doors shall be openable type and shall be provided with limit switches and wired accordingly to trip the HT Breaker if the same is opened when the transformer is ON. The enclosure shall be provided with exhaust fans as an additional measure for cooling.

Drawings and Leaflets

Three copies of manual giving complete instructions for the installation, operation and maintenance with circuit diagram , foundation and trenching details shall be provided with the transformer.

Maximum Allowable Power Transformer Losses

Maximum allowable losses for Dry type distribution transformers with highest voltage for
equipment upto 22 KV, at 50 % and 100 % of the load.

TRANSFORMER CAPACITY KVA	MAXIMUM ALLOWABLE LOSSES (kW) AT 50% LOADING	MAXIMUM ALLOWABLE LOSSES (kW) AT FULL LOAD
100	0.94	2.4
160	1.29	3.3
200	1.5	3.8
250	1.7	4.32
315	2	5.04
400	2.38	6.04
500	2.8	7.25
630	3.34	8.82
800	3.88	10.24
1000	4.5	12
1250	5.19	13.87
1600	6.32	16.8
2000	7.5	20
2500	9.25	24.75

Measurement and Reporting of Transformer Losses

Tests

- All routine tests as per IS2026-1977 / IS:11171-1985 which is applicable shall be carried out at the factory and copies of test reports shall be submitted for approval and records.

- Heat Run Test shall be carried out at an approved test lab as per IS:2026-1977 at no extra cost.

- Impulse test shall be carried out at an approved test lab as per IS:2026-1977
- Measurement of winding resistance.
- Ratio polarity and phase relationship.
- Impedance voltage.
- Load Losses.
- No-Load losses and no-load current.
- Insulation resistance.
- Induced over voltage with-stand.
- Temperature rise.

10.TECHNICAL DATA FOR TRANSFORMER

TENDERER MUST FILL IN THE FOLLOWING TECHNICAL DATA

S. No. **Technical Parameters**

i. Type and class of insulation

ii. Output in KVA (Continuously rated)

iii. Rated Voltage

a. HV (Volts)

b. LV (Volts)

iv. Rated Current

a. HV (amps)

b. LV (amps)

v. No. of phase

vi. Type of cooling

vii. Frequency

viii. Winding Connection

ix. Tapings

x. Vector Group

xi. Ref. Ambient temperature

Temperature rise winding

Class of insulation

xii. Physical Dimensions

a. Length (in mm)

b. Width (in mm)

c. Height (in mm)

xiii. % Impedance

xiv. X/R ratio

xv. Iron losses at normal voltage ratio

xvi. Copper loses at normal voltage ratio at full load

S. No. Technical Parameters

xvii. Efficiency at unity power factor

a. Full load

b. 75% load

c. 50% load

xviii. Regulation at unit power factor

xix. Regulation at 0.8 power factor

xx. Approximate weight

a. Core & winding (Kgs.)

b. Total Weight (Kgs.)

11. HT CABLE 33 KV GRADE XLPE

11.1 GENERAL

Cables shall be aluminium conductor, cross linked polyurethene construction and shall be supplied, inspected, laid, tested and commissioned in accordance with drawings, specifications, relevant Standard Specifications and cable manufacturers instructions.

11.2 MATERIAL

a. **Conductor**

The Conductor shall be made from electrical purity aluminum stranded wires compacted together.

b. **Insulation**

High quality TROPOTHEN - X (XLPE) unfilled insulating compound of natural colour shall be used for insulation. Insulation shall be applied by extrusion process and shall be chemically cross linked in continuos vulcanization process.

c. **Shielding**

Cables shall be provided with conductor shielding as well as insulation shielding and shall consist of extruded semi-conducting compound, additionally insulation shield shall be provided with semi-conducting and metallic tape shield over the extruded insulation shield. XLPE insulation and outer core shielding shall be extruded in one operation.

d. **Armouring**

Armouring shall be applied over the inner sheath and shall comprise of flat steel wires (strips).

e. **Outer Sheath**

Tough outer sheath of heat resisting PVC compound shall be extruded over the armouring in case of armoured cables or over extruded over the armouring in case of armoured cables or over inner sheath in the case of unarmoured cables.

11.3 TESTS

Cables shall be type tested and routine tested in accordance with IS:7098 (Part II).

a. Conductor resistance test.

b. Partial discharge test.

c. High Voltage test.

The following tests shall be carried out at site for insulation between phases and between phase and earth before and after cable laying.

a. Insulation Resistance Test.

b. Continuity resistance test.

c. Sheathing continuity test.

d. Earth test.

e. High Voltage test.

Cables shall be laid with a clearance of at least 75 mm between two cables.

11.4 END TERMINATION OF HT CABLE

Pre-moulded cable terminations for XLPE cable shall be used as per manufacturer's instructions. The steel cone of M-seal Push-On shall consist of highly track resistant insulating section vulcanised to a semi-conducting section. The pad material shall have cold-flow properties and shall be flame retardant.

Each end terminal shall undergo Hi Pot Test.

11.5 LAYING OF HT CABLES

Direct In Ground

The work shall involve excavation of trench and laying of cable(s) as indicated in drawing and Schedule of Quantities.

The depth of the excavation shall not be less than 1050 mm for 33 KV plus radius of cable, from the upper surface of ground. Where more than one multicore cable is laid in the same trench, a horizontal inter spacing of 250 mm shall be left in order ro reduce mutual heating and also to ensure that fault occuring on one cable will not damage the adjacent cable.

Cable shall be laid in cement pipes encased in concrete or hume pipes at all road crossing. Cables shall be laid in trenches over rollers placed inside the trenches. After the cable has been properly laid and straightened, it shall be covered with 80 mm thick layer of sand. Cable shall then be lifted and placed over this sand cushion. Again, the cable shall be covered with a 80 mm layer of sand. Over the sand a layer of cable protection tiles shall be placed by overlapping 50 mm on either side. Trenches shall then be back-filled with earth and shall be consolidated. Suitable cable markers made of cast iron with aluminium paint indicating the voltage grade and direction of run of the cables shall be installed at regular intervals.

11.6 RCC/MASONRY TRENCH

For laying of HT cable in RCC/Masonry trench refer detail on sub-station layout drawing and IS-1255-1983.

12. CABLING FOR TV SYSTEM

12.1 The Co-axial cable shall be of wideband type with operation capability upto 500 MHz.

12.2 The ageing resistance of the co-axial cable shall comply with DIN 47252, Part 2, i.e. max. 5% increase in attenuation at 200 MHz. measured by artifical ageing (14 days at 80 deg. C)

12.3 Cables shall meet or exceed the following specifications.

Construction	**RG-6 MATV Type**	**RG-11 MATV Type**
a Center Conductor	18 AWG tinned copper	14 AWG tinned copper
b. Dielectric	Foam Polyethylene Nom. dia 0.180	Foam Polyethylene Nom. dia 0.280
c. Shield	Foil - 0.003 AI. Tape Braid - 34 AWG 4 end AL. 60% coverage dia 0.212	Foil - 0.003 AI. Tape Braid - 34 AWG 6 end AL. 60% coverage dia 0.314.
d. Jacket	Black PVC flame retardant dia over jacket 0.272 ± 0.008 Min. spot 0.023	Black PVC flame retardant dia over jacket 0.405 ± 0.010 Min. spot 0.032.

Electrical Properties

a. Dielectric Strength	Conductor to shield 2000 VDC	Conductor to shield 1500 VDC
b. Capacitance	16.2 PF / FT, Nom	16.2 PF / FT. Nom
c. Impedance	75.0 ± 3.0 ohms	75.0 ± 3.0 ohms.
d. Attnuation	DB/100 ft.	DB/100 ft.
	0.65 DB @ 5 MHZ	0.35 DB @ 5 MHZ
	0.76 DB @ 10 MHZ	0.94 DB @ 50 MHZ
	0.96 DB @ 20 MHZ	1.28 DB @ 100 MHZ
	1.98 DB @ 100 MHZ	1.78 DB @ 200 MHZ
	4.21 DB @ 450 MHZ	2.20 DB @ 300 MHZ
	4.80 DB @ 550 MHZ	2.75 DB @ 450 MHZ
	6.49 DB @ 1000 MHZ	4.30 DB @ 1000 MHZ
e. Velocity of propagation	82.0% Nom	82.0% Nom
f. DCR	35.47 ohms / 1000 ft.	14.29 ohms / 10000 ft.
g. SRL	30 DB (10 MHz to 300 MHz)	20 DB (5 to 450 Mhz)

12.4 **DIRECTIONAL COUPLERS**

These shall be of Ultra Wideband type and of hybrid circuit design.

These shall have a near flat frequency response over the entire operating range.

These shall have an aluminium cast housing for high frequency radiation resistance.

These shall have 'F' sockets for all input, output and branch ports.

The Tapoffs shall be available in one way, two way and four way configurations.

The splitters shall be available in two way, three way and four way configurations.

The Tapoffs shall be available in different tap values ranging from 11 dB, 15 dB, 20 dB, 25 dB and 30 dB.

These shall meet or exceed the following specifications:

	Tap off	**Splitters**
a. Tap Loss	11-30 dB	--
b. Through Loss	0.5-4 dB	4..0 - 8.0 dB
c. Isolation	> 22 dB	> 22 dB
d. Screening factor	> 50 dB	> 50 db

13. CABLING FOR VOICE SYSTEM

13.1 Scope

This document defines the cabling system and subsystem components to include cable, termination hardware, supporting hardware, and miscellany required to supply, and to install a complete cabling infrastructure supporting voice and video. The intent of this section is to provide pertinent information to allow the vendor to bid the labor, supervision, tooling, materials, and miscellaneous installation hardware and consumables to install a complete system. However, it is the responsibility of the vendor to propose any, and, all items required for a complete system whether or not it is identified in the specification, drawings and bill of materials attached to this specification.

13.2 Applicable Documents:

The cabling system described in this specification is derived in part from the recommendations made in industry standard documents. The list of documents below (or the latest revisions) has bearing on the desired cabling infrastructure are incorporated into this specification by reference:

i) This Technical Specification and Associated Drawings

ii) ANSI/TIA/EIA 568-B Commercial Building Telecommunications Cabling Standard – March 2001

iii) ANSI/EIA/TIA-569-A Commercial Building Standard for Telecommunications Pathways and Spaces - February, 1998

iv) ANSI/EIA/TIA-606 Administration Standard for the Telecommunications Infrastructure of Commercial Buildings - February, 1993

v) ANSI/TIA/EIA-607 Commercial Building Grounding and Bonding Requirements for Telecommunications - August, 1994

13.3 Backbone Wiring

General

The function of the backbone wiring shall be to provide interconnections between telecommunications closets, equipment rooms and entrance facilities in the telecommunications wiring system. The backbone wiring shall consist of the transmission media, intermediate and main cross connects, and mechanical terminations for interconnection of telecommunications closets, equipment rooms and entrance facilities. The backbone wiring shall include transmission media in the building.

The backbone wiring shall use the star topology wherein each telecommunications closet shall be wired to a main cross connect / patch panel or an intermediate cross connect then to a main cross-connects / patch panel. There shall be no more than two hierarchical levels of cross connects / patch panel in the backbone wiring. Interconnections between any two telecommunications closet shall pass through three or fewer cross-connects / patch panel.

Bridged taps shall not be permitted as part of the backbone wiring.

One of the following types of cables shall be used for backbone wiring as defined in schedule of quantities.

i. 100-ohm UTP multiplier backbone cable.
ii. 62.5 / 12.5 um optical fiber cable.

The contractor has to assure that cross talk coupling between individual, unshielded twisted-pairs shall not affect the transmission performance of multi-pair cables.

13.4 Horizontal Wiring

General

The horizontal wiring shall be the portion of the tele communications wiring system that will extend from the work area telecommunications outlet to the telecommunications closet. The horizontal wiring shall include the telecommunications outlet in the work area, mechanical termination for the horizontal cables, and cross-connections located in the telecommunications closet.

The horizontal wiring shall be capable of handling the following minimum services.

1. Voice telecommunications.
2. Premises switching equipment.

The horizontal wiring shall be a star topology with each work area telecommunications outlet connected to a telecommunications closet. Horizontal wiring shall preferably contain no more than one transition point between different forms of the same cable type.

Bridged taps shall not be permitted as part of the horizontal wiring.

The maximum horizontal distance shall be limited to 90 meters (295 ft) independent of media type i.e. the cable length from the mechanical terminating of the media in the telecommunications closet to the telecommunications outlet in the work area shall be limited to this distance. This horizontal distance includes cabling required from the telecommunications outlet to the work station. Horizontal cable shall be limited to one of the following types as listed out in the schedule of quantities.

1. Four-pair 100-ohm unshielded twisted pair (UP) cables.
2. 62.5/125 um optical fiber cable.

Grounding Considerations

Grounding system shall be an integral part of the telecommunications wiring system. In addition to helping protect personnel and equipment from hazardous voltages, the grounding system shall reduce the effect of electromagnetic interference ((EMI) to and from the telecommunications wiring system.

Grounding shall meet the NEC requirements and practices or local authorities or codes whichever impose a more stringent requirement.

The following shall be considered for the grounding system.

Installation conforms with proper practices and requirements.

Each telecommunications closet shall have an appropriate grounding access.

Grounding shall be available for cross-connect frames, patch panel racks, telephone and

data equipment and equipment required for maintenance and testing.

13.5 Backbone Wiring Distances

Telecommunications Closet to Main Cross-Connect

The maximum backbone distance between the main cross-connect patch panel and the mechanical termination in the telecommunications closet shall be as follows:

For 62.5 / 125 ohms optical Fiber cable the distance between Telecommunication closet and main cross connect / patch panel shall not exceed 2000 mts.

For 100 ohm UTP cable, maximum distance between telecommunication closet and main cross connect / panel shall be 800 mts.

Telecommunications equipment which connect directly to main or intermediate cross-connects / patch panel shall done via cables of 30 m or less.

13.6 Telecommunications Closet

A telecommunications closet shall be defined as an area within the building set aside for the exclusive purpose of housing equipment associated with the telecommunications wiring system. There shall be no upper limit on the number of telecommunications closets which may be provided within the building. The telecommunication closet shall have following three possible configurations.

Horizontal Backbone Connection

The telecommunications closet shall contain the mechanical terminations for a portion of the horizontal wiring system and a portion for the backbone wiring system. In such a case the telecom closet shall provide facilities (space, power, grounding etc.) for the passive (cross-connect) / patch panel or active devices or both used to interconnect the two system.

Backbone Wiring System Interconnection

The telecommunications closet may contain the intermediate cross-connect / patch panel or main cross connect / patch panel for different portions of the backbone wiring system. In this usage, the telecommunications closet shall provide facilities for the passive or active devices or both used to interconnect two or more portions or the backbone wiring system.

Entrance Facilities

A telecommunications closet may be used to contain the demarcation point or an interbuilding entrance facility. In this usage, the telecommunications closet shall provide facilities for the active and / or passive devised required to interconnect the demarcation point or interbuilding entrance facility or both to the telecommunication wiring system.

The design of the telecommunications closet shall be as per the requirements of EIA/TIA-569.

13.7 Equipment Room

The equipment room shall be defined as an area within the building where telecommunications systems shall be housed along with the mechanical termination of one or more portions of the telecommunications wiring system. Equipment room shall be considered to be distinct from telecommunications closets because of the nature or complexity of the equipment they contain. Any or all of the functions of a telecommunications closet shall be alternatively provided by an equipment room.

13.8 Cable Specifications

13.8.1 UTP Cabling System

13.8.1.1 Unshielded twisted pair cabling system, TIA / EIA 568-B.1 addendum Category 6 Cabling system

a. Networks Supported	10 / 100 Ethernet, 155 Mbps ATM, 1000 Mbps IEEE 802.3ab Ethernet, and proposed Cat 6 Gigabit Ethernet
b. Warranty	25-year systems warranty; Warranty to cover Bandwidth of the specified and installed cabling system, and the installation costs
c. Performance characteristics to be provided along with bid	Attenuation, Pair-to-pair and PS NEXT, ELFEXT and PSELFEXT, Return Loss, ACR and PS ACR for 4-connector channel

13.8.1.2 Unshielded Twisted Pair, Category 6, TIA / EIA 568-B.2

a. Material:	
b. Conductors	23 AWG solid bare copper or better
c. Insulation	Polyethylene
d. Jacket	Flame Retardant PVC
e. Pair Separator	Cross-member fluted Spline.
f. Approvals	UL Listed ETL verified to TIA / EIA Cat 6
g. Operating temperature	-20 Deg. C to +60 Deg. C
h. Frequency tested up to	Minimum 600 MHz
i. Packing	Box of 305 meters
j. Delay Skew	45ns MAX.
k. Impedance	100 Ohms + / - 15 ohms, 1 to 600 MHz.
l. Performance characteristics to be provided along with bid	Attenuation, Pair-to-pair and PS NEXT, ELFEXT and PSELFEXT, Return Loss, ACR and PS ACR

13.9 Category 5 Riser Cable

This cable shall consist of solid copper conductors insulated with expanded polyethylene covered by a PVC sheet. The core shall be covered with a layer of plastic tape and overlaid with a corrugated PVC plastic. it shall be suitable to be used without conduit. The cable shall meet. EIA/TIA -568, C S A T -529, IEEE 802.3 & 10 B A S E -T. The pair sizes shall be as per the schedule of quantities. The cable shall meet the following specifications.

a. Maximum DC Resistance 26.5 ohm per 100 ft.

b. Maximum D C Unbalanced Resistance 17%

c. Mutual Capacitance at 1 kHz 16 nF per 1000 ft.

13.10 Warranty

Owner seeks warranty for the installed cable plant from the OEM equipment supplier. Bidder shall ensure that the OEM norms for supply, installation, testing and documentation as specified by the OEM supplier shall be adhered to, provided those are in line with TIA / EIA standards and Owner requirement specifications. The warranty shall be provided by the OEM vendor to Owner and shall be administered in India. The duration of the warranty shall be for a minimum of 25 years and shall cover the system performance, application assurance and the costs of the supply of components and installation.

14. CABLING FOR DATA SYSTEM

14.1 Scope

This document defines the cabling system and subsystem components to include cable, termination hardware, supporting hardware, and miscellany required to supply, and to install a complete cabling infrastructure supporting data and video. The intent of this section is to provide pertinent information to allow the vendor to bid the labor, supervision, tooling, materials, and miscellaneous mounting hardware and consumables to install a complete system. However, it is the responsibility of the vendor to propose any, and, all items required for a complete system whether or not it is identified in the specification, drawings and bill of materials attached to this specification.

14.2 Applicable Documents

The cabling system described in this specification is derived in part from the recommendations made in industry standard documents. The list of documents below (or the latest revisions) has bearing on the desired cabling infrastructure are incorporated into this specification by reference:

i. This Technical Specification and Associated Drawings

ii. ANSI/TIA/EIA 568-B Commercial Building Telecommunications Cabling Standard – March 2001

iii. ANSI/EIA/TIA-569-A Commercial Building Standard for Telecommunications Pathways and Spaces - February, 1998

iv. ANSI/EIA/TIA-606 Administration Standard for the Telecommunications Infrastructure of Commercial Buildings - February, 1993

v. ANSI/TIA/EIA-607 Commercial Building Grounding and Bonding Requirements for Telecommunications - August, 1994.

14.3 Cabling System and Component Specifications

14.3.1 UTP Cabling System

14.3.1.1 Unshielded twisted pair cabling system, TIA / EIA 568-B.1 addendum Category 6 Cabling system

Networks Supported	10 / 100 Ethernet, 155 Mbps ATM, 1000 Mbps IEEE 802.3ab Ethernet, and proposed Cat 6 Gigabit Ethernet
Warranty	25-year systems warranty; Warranty to cover Bandwidth of the specified and installed cabling system, and the installation costs
Performance characteristics to be provided along with bid	Attenuation, Pair-to-pair and PS NEXT, ELFEXT and PSELFEXT, Return Loss, ACR and PS ACR for 4-connector channel

14.3.1.2 Unshielded Twisted Pair, Category 6, TIA / EIA 568-B.2

Material:	
Conductors	23 AWG solid bare copper or better
Insulation	Polyethylene
Jacket	Flame Retardant PVC
Pair Separator	Cross-member fluted Spline.
Approvals	UL Listed ETL verified to TIA / EIA Cat 6
Operating temperature	-20 Deg. C to +60 Deg. C
Frequency tested up to	Minimum 600 MHz
Packing	Box of 305 meters
Delay Skew	45ns MAX.
Impedance	100 Ohms + / - 15 ohms, 1 to 600 MHz.
Performance characteristics to be provided along with bid	Attenuation, Pair-to-pair and PS NEXT, ELFEXT and PSELFEXT, Return Loss, ACR and PS ACR

14.3.2 UTP Jacks

Type	**PCB based, Unshielded Twisted Pair, Category 6, TIA / EIA 568-B.2**
Durability	
Modular Jack	750 mating cycles
Wire terminal	200 termination cycles
Accessories	Strain relief and bend-limiting boot for cable Integrated hinged dust cover
Materials	
Housing	Polyphenylene oxide, 94V-0 rated
Wiring blocks	Polycarbonate, 94V-0 rated
Jack contacts	Phosphorous bronze, plated with 1.27micro-meter thick gold
Approvals	UL listed
Performance Characteristics to be provided with bid	Attenuation, NEXT, PS NEXT, FEXT and Return Loss

14.3.3 UTP Jack Panels

Type	**24-port, PCB based, Unshielded Twisted Pair, Category 6, TIA / EIA 568-B.2**
Ports	24
Port arrangement	Modules of 6-ports each, arranged 1port x 6.
Category	Category 6
Circuit Identification Scheme	Icons on each of 24-ports
Port Identification	9mm or 12mm Labels on each of 24-ports (to be included in supply)
Height	1 U (1.75 inches)
Durability	
Modular Jack	750 mating cycles
Wire terminal (110 block)	200 termination cycles
Accessories	Strain relief and bend limiting boot for cable
Materials	
Housing	Polyphenylene oxide, 94V-0 rated
Wiring blocks	Polycarbonate, 94V-0 rated
Jack contacts	Phosphhorous bronze, plated with 1.27micro-meter thick gold
Panel	Black, powder coated steel
Approvals	UL listed
Termination Pattern	TIA / EIA 568 A and B;
Performance Characteristics to be provided along with bid	Attenuation, NEXT, PS NEXT, FEXT and Return Loss

14.3.4 Faceplates

Type	**1-port, White surface box**
Material	ABS / UL 94 V-0
No. of ports	One

14.3.5 Workstation / Equipment Cords

Type	**Unshielded Twisted Pair, Category 6, TIA / EIA 568-B.2**
Conductor	24 AWG 7 / 32, stranded copper
Length	7-feet
Plug Protection	Matching colored snag-less, elastomer polyolefin boot
Warranty	25-year component warranty
Category	Category 5
Plug	
Housing	Clear polycarbonate

Terminals	Phosphor Bronze, 50 micron gold plating over selected area and gold flash over remainder, over 100 micron nickel underplate
Load bar	PBT polyester
Jacket	PVC
Insulation	Flame Retardant Polyethylene

14.3.6 Fiber optic Cable

Cable Type	**6-core, Multimode, 10G Ethernet OM3, Armored, loose-tube, Gel Filled**
Fiber type	50 / 125, Laser Grade, 250 micron primary coated buffers
No. of cores	6
Cable Construction	BELLCORE GR 20 / IEC 794-1
Attenuation	
@850nm	3.5 dB / KM
@1300nm	1.5 dB / KM
Bandwidth	
@850nm	1500 MHz-KM
@1300nm	500 MHz-KM
Network Support	
10 / 100 Ethernet	2000m
155 Mbps ATM	2000m
1000 Base SX	900m
1000 Base Lx	550m without Mode Conditioning launch patch cord.
Tensile rating	1200N
Maximum Crush resistance	3000N
Operating Temperature	-40 Degree C to +60 Degree C
Armor	Corrugated Steel tape Armor

Note: For Composite fiber optic cables, the above specifications for SM and MM fibers apply.

14.3.7 Fiber Optic Connectors

Connector Type	**SC-Style, Simplex**
Operating temperature	-40 Degree C to +85 Degree C
Durability & color	
MM connectors	500 cycles, Beige
SM connectors	220 cycles, Blue
Ferrules	Pre-radiused Ceramic Ferrules
Attenuation	Not more than 0.75 dB per mated pair

14.3.8 Fiber Optic Patch panels

Fiber optic patch panel	**19-inch, Rack mounted Fiber optic patch panel**
Height	3 U, 5.25 inches
# of fibers	48,96,192
# of OSP Cables for termination	Minimum 2
Grounding	2 Nos. of earthing lugs, pre-loaded
Cable Management rings	Front and rear cable management rings, pre-loaded
# of 6-port / 12-port adapter plates	8 / 8 Max.

Fiber optic patch panel	**19-inch, Rack mounted Fiber optic patch panel**
Height	1 U, 1.75 inches
# of fibers	18,36,72
# of OSP Cables for termination	Minimum 2
Grounding	2 Nos. of earthing lugs, pre-loaded
Cable Management rings	Front and rear cable management rings, pre-loaded
# of 6-port / 12-port adapter plates	3 / 3 Max.

14.3.9 Fiber Optic Adapter plates

Fiber Optic adapter plate	**6-port, SC-Style, MM**
Attenuation	Max of 0.75 dB per mated pair

14.3.10 Fiber Optic Patch Cord.

Fiber Optic Patch Cords	**50/ 125 Ethernet Patch Cord**
Bandwidth	
@850nm	500 MHz-KM
@1300nm	500 MHz-KM
Insertion Loss	Less than 0.5 dB

14.4 Warranty

Owner seeks warranty for the installed cable plant from the OEM equipment supplier. Bidder shall ensure that the OEM norms for supply, installation, testing and documentation as specified by the OEM supplier shall be adhered to, provided those are in line with TIA / EIA standards and Owner requirement specifications. The warranty shall be provided by the OEM vendor to Owner and shall be administered in India. The duration of the warranty shall be for a minimum of 25 years and shall cover the system performance, application assurance and the costs of the supply of components and installation.

B. INTELLIGENT ADDRESSABLE FIRE ALARM SYSTEM

1. BASIS OF DESIGN

An Intelligent Fire Alarm System (IFAS) shall be provided to effect total control over the life safety services required in the building. The IFAS shall be of the digital, distributed processing, real time, multitasking, multi-user and multi-location type.

The IFAS provided shall be able to tie-up the following Mechanical, Electrical & Low Voltage Services into an integrated system.

a. Air Handling Units
b. Staircase pressurization fans, Lift shafts and lift lobbies pressurization fans.
c. Public address system.
d. Lifts
e. Toilet Exhaust Fan
f. Smoke evacuation system
g. Fire fighting system

The system shall be provided with Addressable and Analog fire alarm initiating, annunciating and control devices.

The addressable and intelligent system shall be such that smoke sensors beam detectors, thermal sensors, manual call points, etc., can be identified with point address. The system shall be capable of :

a. Setting smoke sensor sensitivity remotely (from the Fire Work Station) to either high sensitivity manually or on a pre-programmed sequence e.g. occupied/unoccupied period. The FAS shall be able to recognize normal and alarm conditions, below normal sensor values that reveal trouble condition, and above normal values that indicate either a prealarm condition or the need of maintenance.

b. Read-out or address an actual space temperature at thermal detector points. The operator shall also be able to adjust alarm and prealarm thresholds and other parameters for the smoke sensors.

c. Provide a maintenance/pre-alert alarm capability at smoke sensors to prevent the detectors from indicating a false alarm due to dust, dirt etc.

d. Provide alarm verification of individual smoke sensors. Systems that performs alarm verification on a zone basis shall not be acceptable. Alarm verification shall be printed on the printer at the Control Station's printer to enhance system maintenance and identify possible problem areas.

e. Provide local numeric point address and LED display of device and current condition of the point. Local annunciation shall not interfere with annunciation from the Fire Control System.

f. Provide outputs that are addressable, i.e. outputs shall have point address. The operator shall be able to command such points manually or assign the points to Logical Point Groups (Software Zones) for pre-programmed operation.

In the event of a fire alarm, but not in a fault condition, the following action shall be performed automatically.

a. The System Alarm LED on the main fire alarm control panel shall flash.

b. A local piezo-electric sounder in the control panel shall be sounded.

c. The LCD display on the main fire alarm control panel shall indicate all information associated with Fire Alarm condition including the type of alarm point and its location within the premises.

d. Printing and history storage equipment shall log the information associated with the Fire Alarm Control Panel condition, along with the time and date of occurrence.

e. All system output programs assigned via control-by-event programs that are to be activated by a particular point in alarm shall be executed, and the associated system outputs (alarm notification appliances and/or relays) shall be activated.

f. The audio portion of the system shall direct the proper signal (tone or voice) to the appropriate speaker circuit.

g. All lifts initiated through the systems will automatically be returned to Ground Floor.

h. Air handling units on affected floors shall automatically be switched OFF and simultaneously respective fire dampers shall also be closed.

j. Staircase pressurization fans shall be put on.

k. Toilet exhaust fans on affected floors shall be put off.

l. Pre-recorded alarm messages shall be played through interface with Public Address system.

m. Start smoke evacuation system.

2. FIRE ALARM CONTROL PANEL (FACP)

2.1 The distributed Intelligent Fire Alarm Control Panel (FACP) shall function as fully stand-alone panel as well as providing a communication interface to the central station. FACP shall has its own microprocessor, software and memory and should be listed under UL864 or EN54. In the event of failure of the central or communication breakdown between the central station and the FACP, the FACP shall automatically operate on stand-alone mode without sacrificing any functions.

2.2 The memory data for panel configuration and operation shall reside in non-volatile memory (EEPROM). Removal of the board shall not cause loss of memory. If such removal can cause loss of memory, then the card containing the memory shall have battery back-up for upto 100 hours on the board itself.

2.3 FACPs shall supervise detection circuits and shall generate an alarm in case of abnormal condition.

2.4 FACPs shall provide general purpose inputs for monitoring such functions as low battery or AC power failure. FACPs shall provide tamper protection and commandable outputs, which can operate relays or logic level devices. Output commands shall take any of, but not limited to, maintained command, Momentary Command, Alarm Follow, or Alarm latch as required. Any relay in the FACP which is intended to be removable shall be supervised against removal.

2.5 Smoke detectors shall be powered using the FACP-based smoke detection circuits. FACPs shall provide for resetting smoke detectors, fault-isolation and sensor loop operation. It shall be possible to mix different fire devices within the same FACP to optimize field wiring.

2.6 FACPs shall provide indication for communication with the central console and alarm/trouble conditions in each sensor loops.

2.7 FACPs shall provide monitoring and control of one floor or area or for multiple floors or areas. FACPs shall meet the following requirements to assure the integrity and reliability of the system :

a. The FACP shall be UL or EN54 listed independently as a fire alarm control panel.

b. FACP electronics shall be contained in an enclosure made of minimum 16 gauge steel. Access to FACP switches and electronics shall be by key-lock. Usage of no other tools should be required. Visual indicators of FSP status for each zone shall be visible without opening the key-locked cover.

2.8 All hardware and software to allow the FACP configuration and operation to be changed shall be provided. Memory data shall be contained in non-volatile memory (EPROM).

2.9 Alarm verification with field-adjustable time from 0 to 60 seconds for individual smoke detector shall be provided. During the alarm verification, the panel shall retard the alarm until the end of the period. If the alarm is only a transient smoke alarm, the panel shall automatically reset the alarm. Only a verified alarm shall initiate the alarm sequence for the software zone (Logical Point Group) or point. Final time setting shall be as per approval of the fire authorities. When alarm verification is being performed on a smoke detector, the action shall be printed on the listed printer(s).

2.10 Digital numeric display at the FACP shall be provided to indicate point in alarm or trouble. In such systems, means for manually scanning the points in trouble shall be provided and a trouble and alarm LED shall be used to indicate that there are points in alarm/trouble. The alarm/trouble LED shall only extinguish when all alarm/troubles are cleared from the loop.

2.11 It shall be possible to command test, reset and alarm silence from both the FACP and the central console.

2.12 FACP switches shall allow authorized personnel to accomplish the following, independent of the central console :

a. Initiate a general alarm condition.

b. Silence the local audible alarm.

c. It shall be possible to acknowledge (Silence the local FACP audible without silencing the alarm indicating devices (hooters).

d. Reset all zones (Logical Point Group) / points, after all initiating devices have returned to normal.

e. Perform a complete operational test of the microprocessor and memory with a visual indication with each board.

f. Test all panel LEDs for proper operation without causing a change in the condition of any zone (Logical Point Group)

g. Walk Test

2.13 Software zones/loops shall be circuited and protected by Fault Isolation Modules such that in the event of a zone/loop short-circuit, not more than twenty (20) devices shall be left non-functional.

2.14 Intelligent Smoke and thermal sensors shall be located as shown and shall report sensed levels in analog form.

2.15 Monitor modules shall be provided to monitor and address contact-type input devices. The monitor module shall be supervised by FACP.

2.16 The FACP shall process the true continuous analog signal from the sensors. System using step setting to represent analog signal will not be accepted. The FACP shall be able to set dual alarms threshold for occupied and unoccupied periods. During unoccupied period, the alarm threshold shall automatically be lowered to facilitate quicker response. In addition, the FACP shall further process all analog values for pre-alarm limits to prompt the operator for early maintenance. If a sensor value increases to an above normal level or a pre-alarm limit for an extended duration, the FACP shall communicate a maintenance pre-alarm.

a. Any time sensor value transitions beyond the secondary and higher limit value, an alarm initiation and report shall be issued.

b. Limits and sensor values shall be displayed, modifiable, and reported in decimal values.

c. The FACP shall have Drift Compensation facility to compensate for environment. The FACP shall have the ability to recalibrate Pre-alarm and Alarm limits if required, after comparing each sensor’s operating characteristics

with the set sensitivity. This should be carried out at least once in every 24 hours. FACP should annunciate trouble conditions when sensor(s) is beyond compensation range (excessively dirty sensor).

d. The FACP should be UL listed or EN 54 approved to provide the sensitivity measurement and documentation required by NFPA72E.

2.17 FACP shall be backed up with its built in UPS power and shall also be connected to central DG Power available in the building.

2.18 FACP shall be provided with following features :

Charger Rate Control

Control-by-Time Non-Alarm Module Reporting

Day/Night Sensitivity Periodic Detector Test

Device Blink Control Remote Page

Drift Compensation Trouble Reminder

NFPA 72 Sensitivity Test Verification Counters

System Status Reports Walk Test

Security Monitor Points Maintenance Alert

Alarm Verification System Configuration Report

Printer Interface System Point Report

Event Historical log Programmable Automatic Timed and Manual Signal Silence

Programmable Manual Signal Silence Inhibit Timer Control-By-Event with Boolean Logic and Timer Control

2.19 FACP shall have real-time clock to prevent loss of time and date in case of failure of power supplies.

2.20 The display on FACP shall provide indication for AC Power, System Alarm, System Trouble/Security Alarm, Display Trouble and Signal Silence.

2.21 Minimum two different password levels will be provided to prevent unauthorized System control or programming.

2.22 Operator control switches for Signal Silence, lamp Test, Reset, System Test and Acknowledge shall be provided.

2.23 The FACP should truly field programmable. This would mean that in the event of change of any logic, detector / zone sequence alteration, the operator can initiate these by use of the alpha-numeric keys on the FACP panel to reconfigure the above parameters. Panels, which require external programming devices to perform the above function will not be acceptable.

2.24 The FACP should have a degraded mode of operation. In the event of the CPU failure the field devices (detectors & modules) should report the condition on a simple digital communication mode to ensure reliability even during failure.

2.25 Power supply unit of FACP shall have following characters :

a. The main power supply shall be 230 VAC±10%, 50 Hz±1% and shall in turn provide all necessary power of the FACP.

b. It shall provide a battery charger for 24 hours for standby power using dual-rate charging technique for fast battery recharge.

c. It shall provide a very low frequency sweep earth fault detect circuit, capable of detecting earth faults on sensitive addressable modules.

d. It shall be power-limiting using Positive Temperature Coefficient (PTC) resistor.

e. It shall provide indication for battery voltage and charging current.

2.26 For ease of service, all wiring terminal blocks shall be plug-in type and shall have sufficient capacity for 18 to 12 AWG wire termination. Fixed terminal blocks shall not be acceptable.

3. DETECTORS & ADDRESSABLE DEVICES

3.1 GENERAL FEATURES COMMON TO ALL DETECTORS :

a. Compatibility : All automatic fire detectors shall be inter changeable without requiring different mounting bases or alterations in the signal panel.

b. Response Spectrum : Combustion gas detectors shall respond to both visible and invisible aerosols; size and colour of the aerosols shall not have a decisive influence on the response of the detector.

c. Sensitivity : On average 30 mgs of burned material per cu.m. (as measured in a 1 cu.m. chamber) shall release an alarm sensitivity which shall be adjustable according to the use of the space.

d. Power Consumption : Each detector shall use the minimum of power, for economic circuits, so that it shall have capacity to connect atleast 99 detectors, 50 modules and 20 fault isolator modules in one loop.

e. Built-in-response indicator : Each detector shall incorporate indicator “LED” at the detector which shall blink during normal condition and light up on actuation

of the detector to locate the detector which is operated. The detector shall not be affected by the failure of the response indicator lamp.

f. Maintenance : All detectors shall be fitted either with plug-in system or bayonet type connections only, from the maintenance and compatibility point of view.

g. Construction : The detector shall be vibration and shock proof. When disassembling for cleaning purposes, its components must not be damaged by static over voltage.

h. Atmospheric and Thermal Disturbance : The detector shall so designed as to be practically immune to environmental criteria such as air currents, humidity, temperature fluctuations, pressure and shall not trigger false alarm, due to the above conditions.

i. Continuous Operation : An alarm release shall not effect a detector's functioning. After resetting the alarm, the detector shall resume operation without any readjustment.

j. Adaptability to ambient conditions : Detectors shall be designed for adaptability to humid locations. No performance deterioration shall be acceptable.

3.2 ADDRESSABLE PHOTOELECTRIC SMOKE DETECTORS

Smoke detectors shall be intelligent and addressable devices, and shall connect with two wires to one of the Fire Alarm Control Panel loops. Minimum to 99 intelligent detectors should connect to one loop. The detectors shall use the photoelectric (light-scattering) principal to measure smoke density and shall, on command from the control panel, send data to the panel representing the analog value for smoke density. The detectors shall be ceiling mounted type and shall include a twist-lock base.

The detectors shall provide a test means whereby they will simulate an alarm condition and report that condition to the control panel. Such a test may activated remotely on command from the control panel.

The detectors shall provide address-setting means on the detector head using rotary decimal switches. Systems which use binary jumpers or DIP switches to set the detector address shall not be acceptable. The detectors shall also store an internal identifying code, which the control panel shall use to identify the type of detector. Detectors providing address setting through hand held programmers shall also be accepted.

The detectors shall provide dual alarm and power LEDs. Both LEDs shall flash under normal conditions, indicating that the detector is operational and in regular communication with the control panel. Both LEDs may be placed into steady illumination by the control panel, indicating that an alarm condition has been detected. An output connection shall also be provided in the base to connect an external remote alarm LED.

The detector sensitivity shall be set through the Fire Alarm Control Panel, and shall be adjustable in the field through the field programming of the system. Sensitivity may be automatically adjusted by the panel on a time-of-day basis.

Using software in the FACP, the detectors shall compensate for dust accumulation and other slow environmental changes which may affect their performance. The detectors shall be listed by UL as meeting the calibrated sensitivity test requirements of NFPA Standard 72.

The area covered by each smoke detector shall be as per IS-2189.

3.3 ADDRESSABLE THERMAL DETECTORS

Thermal detectors shall be intelligent and adderessable devices, and shall connect with two wires to one of the Fire Alarm Control Panel loops. Minimum 99 intelligent thermal detectors may connect to one loop.

The detectors shall use an electronic detector to measure thermal conditions caused by a fire and shall, on command from the control panel, send data to the panel representing the analog level of such thermal measurements. The detectors shall be ceiling-mounted type and shall include a twist-lock base.

The detectors shall provide a test means whereby they will simulate an alarm condition and report that condition to the control panel. Such a test may be initiated remotely on command from the control panel.

The detectors shall provide address-setting means on the detector head using rotary decimal switches. Systems which use binary jumpers or DIP switches to set the address shall not be acceptable. Detectors providing address setting through hand held programmers shall also be accepted.

The detectors shall provide dual alarm and power LEDs. Both LEDs shall flash under normal conditions. In certain applications, LEDs may be selected to be polled without flashing through system programming. Both LEDs may be placed into steady illumination by the control panel, indicating that an alarm condition has been detected.

An output connection shall be provided in the base to connect an external remote alarm LED.

3.4 ADDRESSABLE MANUAL STATIONS

Addressable manual stations shall be provided to connect to the Fire Alarm Control Panel loops. Minimum 99 addressable manual stations may be connected to one loop.

The manual stations shall on command from the Control Panel send data to the panel representing the state of the manual station.

Press/break stations with resettable capability are also acceptable.

Manual stations shall be constructed of high impact LEXAN sheet with clearly visible operating instructions provided on the cover. The word FIRE shall appear on the front of the stations in raised letters.

Stations shall be suitable for surface mounting as shown on the plans, or semi-flush mounting, and shall be installed not less than 42 inches, nor more than 48 inches above the finished floor unless otherwise specified by applicable building codes.

3.5 ADDRESSABLE MONITOR MODULE

The monitor module shall provide address-setting and shall also store an internal identifying code which the Fire Alarm Control Panel shall use to identify the type of device. Modules using binary jumpers are not acceptable. An LED shall be provided which shall flash under normal conditions, indicating that the monitor module is operational and in regular communication with the control panel.

3.6 RESPONSE INDICATOR

In addition to built-in response indicator in each detector. Secondary response indicator of LED type shall be provided outside the rooms wherever asked for by the Architect/Interior Designer, for indication of fire through detector in the room. The design & colour shall be as per Interior Designer approval.

3.7 CONTROL MODULE

The control module shall provide address-setting and shall also store an internal identifying code which the control panel shall use to identify the type of device. Modules which use binary jumpers are not acceptable. An LED shall be provided which shall flash under normal conditions, indicating that the control module is operational and is in regular communication with the control panel.

3.8 ADDRESSABLE HOOTERS

All field hooters should preferably be addressable and software configurable. All hooters should be able to provide at least a minimum of 3 different tones, which should be user configurable. The minimum decibel level of each hooter should be 90db. All hooters should be UL/FM listed.

4. CABLES

All PVC insulated FRLS copper conductor stranded cables shall be 650 volts grade and shall generally conform to IS-1554-1988 and meet the signal cabling requirement of the system manufacturer.

Strands of cables shall not be cut to accommodate & connect to the terminals. Terminals shall have sufficient cross-sectional area to take all the strands.

Cables shall be laid by skilled and experienced workmen using adequate rollers to minimize stretching of the cable. The cable drums shall be placed on jacks before unwinding the cable. Great care shall be exercised in laying cables to avoid forming kinks. At all changes in direction in horizontal and vertical planes, the cable shall be bent smooth with a radius as recommended by the manufacturer's. All cables shall be laid with minimum one diameter gap and shall be clamped at every metre and shall be tagged for identification with aluminium tag and clamped properly. Tags shall be provided at both ends and all changes in directions both sides of wall and floor

crossings. All cable shall be identified by embossing on the tag the size of the cable, place of origin and termination.

These shall be measured on linear basis including the fittings required like, end termination junction boxes.

5 EMERGENCY VOICE EVACUATION (EVAC)

The FACP shall contain all equipment required for audio, communication, signaling and supervisory functions. This shall include speaker zone indication, digital voice units, microphone.

a. Function : The EVAC system equipment shall perform following functions :

   i. Operate as a supervised dual channel emergency voice communication system.

   ii. Operate as a two-way emergency communication system control center.

   iii. Supervise condition of every connection circuit.

   iv. Audibly and visually annunciate any trouble condition of tone generators and digital voice units required for normal operation of the system.

   v. Provide all-call activities through activation of a single control switch. Provide selectable zone calling.

   vi. Provide automatic, digitally-recorded voice messages or field-programmed through the microphone.

b. The system shall be modular in construction and shall be capable of being field programmable without requiring the return of any components to the manufacturer.

c. The system and associated equipment shall be protected against unusually high voltage surges or line transients.

6. FUNCTIONAL REQUIREMENTS

6.1 INTELLIGENT SYSTEM DEVICES

a. Each device shall be assigned a unique address via easily understood decade (01 to 99) switch. Address selection via binary switches is not acceptable. Devices which take their address from their position on the circuit are unacceptable.

b. Devices shall receive power and communication from the same pair of conductors.

6.2 SENSORS

a. All fire sensors shall mount on a common base to facilitate the changing of sensor type if building conditions change. The base shall be incompatible with conventional detectors to preclude the mounting of a non-intelligent device.

b. Each sensor shall contain an LED which shall blink each time the sensor is scanned by the FACP. If the FACP determines that the sensor is in alarm, the FACP shall command the sensor LED to got latched on.

c. Each sensor shall be capable of being tested for alarm via command from the FACP.

d. Each sensor shall respond to FACP scan for information with its type identification to preclude inadvertent substitution of another sensor type. The FACP shall continue operation with the detector installed but shall initiate a mismatch (trouble) condition until the proper detector is installed.

e. Each sensor shall respond to FACP scan for information with an analog representation of measured fire-related phenomenon (smoke density, particles of combustion, temperature). Systems which only monitor the presence of conventional detector in an addressable base shall not be acceptable.

f. Photoelectric smoke sensors shall contain an optical sensing chamber with nominal sensitivity of 2.3% foot obstruction.

g. Ionization smoke sensors shall contain a unipolar dual chamber with nominal sensitivity of 2.3% foot obscuration.

6.3 INPUT DEVICES

a. The input device shall provide an addressable input for N.O. or N.C. contact devices such as manual stations etc.

b. The input device shall provide a supervised initiating circuit. An open-circuit fault shall annunciate at the FACP (subsequent alarms shall be reported).

c. The device shall contain an LED which will blink upon being scanned by the FACP. Upon determination of an alarm condition, the LED shall be latched on.

6.4 AUTOMATIC FUNCTIONS AT FACP

The alarms shall be displayed at the FACP on an LCD display. The display shall indicate the device in alarm by ID number, the appropriate alarm state, and the current time and date. It shall also display a point description of minimum 32 characters and, the respective analog value. The display shall also contain a minimum 40 characters alarm message. It shall be possible to see the number of acknowledged alarms, number of current fire alarms, number of trouble conditions and number of other miscellaneous alarms in the system. The FACP printer shall print out same information displayed on the LCD display. The LCD display and printer shall be powered directly from the panel.

6.5 MANUAL FUNCTIONS AT FACP

I. At any given time, operator shall have the following manual capabilities at FACP by means of switches located behind a key-locked cover :

a. Initiate an alarm summary display on the FACP LCD display. This display shall step through all currently active alarms in the system.

b. Initiate a summary printout of all currently active alarms on the FACP printer.

c. Initiate an "all-point summary" printout on the FACP printer recording the status of each system point (initiating circuits, indicating circuits etc.)

II. At any time, the operator shall have following manual capabilities at the FACP under password control; Operator privileges and ID numbers of upto four digits shall assignable by the main operator or designated alternate. Actions taken by operators shall automatically be printed on the FACP printer with operator initials, time and date.

a. Commands output points to different mode. Such commands shall be printed with selected descriptors ON/OFF/AUTO, OPEN/CLOSE, DAY/NIGHT etc. In addition, command shall be used to ISOLATE or DISCONNECT points. When isolated, alarms and troubles shall be received but not acted upon.

b. Modify system parameters. Alphanumeric key pad shall be provided for operators to modify the following parameters :

- change sensor alarm and pre-alarm threshold
- update date and time
- change point descriptors
- change action message
- disable a point
- change sensor verification time
- change password
- activate/deactivate indicating output control point
- control-by-event programs on line

c. Select a system status report for printing on the printer from the control station. The following real time reports shall be provided :

- all point log.
- alarm summary
- trouble summary
- status summary
- sensitivity log
- disabled points log.
- isolated points log
- disconnected points log
- logical group points log

The sensitivity log shall print the analog value of each addressable analog sensor.

d. Select printing of a trend sensitivity log which when enabled, shall print minimum last 24 analog values for every addressable analog sensor taken at predetermined intervals. Systems which limit the number of addressable analog sensors which can be trended are not acceptable.

e. Select a sequence of programmed commands which can be automatically executed, in sequence, via a single command.

f. Perform a walk-test function such that a operation can be periodically checked out for all initiating devices on a zone. In walk test mode, all initiators on the selected zone shall automatically be isolated. As each device is placed into an alarm or trouble condition, the FACP shall print the condition and automatically reset the device. No audible signals shall be initiated from the zone to prevent disruption of building occupants. If a zone is inadvertently left in the walk-test mode, it shall automatically reset to normal after a five-minute idle time is exceeded.

6.6 SYSTEM SUPERVISION

a. In the normal supervisory condition, only the "POWER" ON, and "RUN" conditions, shall be illuminated. The LCD display shall display "System Normal" and the current time and date.

b. The LCD display shall indicate the loss of power condition and the printer shall record the same. Following restoration of normal AC power, the trouble indicators shall be automatically reset and the printer shall record the 'return to normal condition'.

c. The LCD display shall indicate the loop in trouble and the printer shall record same.

d. The LCD display shall indicate trouble and the printer shall record same. Operation of a momentary "Silence" switch shall silence the audible trouble signal but the visual "Trouble" LEDs shall remain ON until the malfunction has been corrected and the system has reset. The FACP printer shall record this action.

6.7 PROGRAMMING OF FACP

The LCD display and printer programming shall be accomplished on site by means of lap-top personal computer which shall plug into the FACP. Modules requiring off-site programming are not acceptable. LCD shall initiate test of all addressable sensors in the system.

Programming functions shall include alarm/trouble type assignment, point descriptor assignment, alarm message assignment etc. Data file for the LCD display and a printer shall be stored in EEPROM.

6.8 OTHER DEVICES

Fault-isolation of fire zones (Logical Point Group) / circuit modules shall be provided to enable part of a fault-tolerant loop to continue operating when a short occurs in the loop.

6.9 FIRE ALARM GRAPHICS SOFTWARE (FAS)

The status of each detector shall be monitored by the FAS.

Using the FAS, the operator shall be able to adjust the sensitivity of any detector.

Using the FAS, the operator shall be able to define the entire database for the file system. Fire system which are not field programmable shall not be accepted.

The FAS operator shall be able to acknowledge alarms or trouble messages at the FAS.

It shall be necessary for all alarm or trouble conditions to be acknowledge at the fire system central panel.

FAS software shall be upload/download type as well as with graphic facilities.

The contractor shall list out the graphic facilities being provided by him.

All devices & detectors shall be visible on building plans superimposed in FAS software.

6.10 FIRE CONTROL SEQUENCES

Upon activation of a fire alarm devices :

FACP will display the exact address & alarm in the panel.

The Central Control Station shall switch OFF the AHUs of the affected floor fire damper and toilet exhaust fans while the AHUs on the other floors shall remain operational so as to keep the area under positive pressure.

Staircase pressurization fans shall be operated through the fire alarm system.

Appropriate fire messages shall start to broadcast automatically (synthesized voice) after time delay.

Activate the fire alarm signaling devices.

Capture the lifts and return them to the ground floor.

The lifts and escalators alarms (provided by lift and escalator contractor) shall be tied to the Fire Alarm System. The Fire Alarm System shall function as follows :

In the event of a fire, a signal will be provided by the Fire Alarm System to return all lifts to ground floor.

Should an emergency alarm originate from an individual lift, an audible alarm shall sound at both Fire Control Stations, and print out at the printers.

When an alarm is detected

- all include annunciating devices on the floor one above and one below shall sound.
- stairwell pressurization fans shall be started.
- the air handling unit for the floor shall be stopped.
- the air handling unit on the floor above and the floor below shall be started unless those floors are also in alarm.
- Smoke extraction from Exhibition Hall.

If the alarm has not been acknowledge at the central panel within one minute, all audible annunciating devices on the floor above and the floor below shall sound.

It the alarm has not been acknowledge at the central panel within three minutes, all audible annunciating devices on the building shall sound.

It shall be possible to accomplish the following, independent of the central console :

a. Initiate a general alarm condition.

b. Silence the local audible.

c. Silence the alarm signals. It shall be possible to acknowledge (silence) the local FACP audible without silencing the alarm indicating devices (hooters).

d. Reset all zones, after all initiating devices have returned to normal.

e. Perform a complete operational test of the microprocessor and memory with a visual indication of satisfactory communication with each board.

f. Test all panel LED's for proper operation without causing a change in the condition of any zone.

g. Print reports of all points based on Historical data.

h. Read the status of each point based on LCD display and print the status information.

j. Change passwords.

k. Disable points/zones.

l. Change sensitivity of sensors.

m. Perform a walk test and generate walk test report.

C. PA SYSTEM

1. PUBLIC ADDRESS (PA) SYSTEM FOR FIRE EVACUATION:

a. PA System shall cater to fire evacuation speakers for broadcasting alarm signals and evacuation messages in the event of an emergency. The same speakers shall be used for soft music for the entire floor.

b. The Public Address System shall operate on 24 VDC power and shall suitable for continuous duty, be of modular design and utilize component based on solid state technology.

2. CODES AND STANDARDS:

a. The design, manufacture and performance of equipment shall comply with all currently applicable statutes, regulations and safety codes. Nothing in this specification shall be construed to relieve Vendor of this responsibility. All the components should be designed and installed as per NFPA - 72.

b. The Public Address System shall be robust and the components such as speaker amplifier, tone generator, wiring circuits, uninterrupted power supplies, standby batteries along with CD player shall be constantly electrically supervised for any single ground fault, short or open circuit.

3. SYSTEM REQUIREMENTS:

a. P.A. System shall be capable of generating both emergency and evacuation messages to 'ALL' or selected speaker zones located within the floor. It shall also able to play music 'ALL' or selected speaker zone.

The system shall essentially consist of microprocessor based central control equipment with zone selectable announcement.

Normally background music shall be played, in selected zone only, using the central CD/Cassette Player Source. When, a particular zone is selected for making an announcement, the background music to that particular zone only shall be cut-off and the announcement relayed. All other zones shall remain unaffected. Once the announcement is over, the music shall resume.

b. An emergency call shall include following:

i) A special slow-whoop signal, sweeping from 500Hz up to 1200 Hz.

ii) PA pre-recorded message shall be broadcasted on completion of the slow-whooping signal.

iii) It shall be possible to repeat both of the above procedures to be repeated during the emergency period.

iv) Provision for recording the message in the field shall be available.

4. SYSTEM SPECIFICATIONS:

a. The system shall provide the Voice paging to individual, grouped or to all zones, from the fire controller's room via microphone from the fire alarm control panel.

b. Voice paging to individual or all zones, from the microphone shall over ride broadcast or recorded messages, in those selected zones. The paging zones are to select via a keypad located at the microphone location in the Security Room.

c. The system shall be capable of being easily extended to accommodate (25% spare capacity) additional handsets, speakers, etc. in future. For this purpose, adequate spare capacity shall be provided in equipment. The public address system shall incorporate following operational features:

i) A 'siren tone' oscillator and a siren switch shall be provided for emergency purposes. This shall be such that it can be actuated from the handset station only fitted on the main fire alarm control panel. The siren tone shall broadcast over all the loudspeakers.

ii) A 'Testing signal' tone oscillator and a test signal switch shall be provided for testing purposes. The test signal shall be broadcast over all the loudspeakers.

iii) The frequencies of the tones for 'call attention', 'emergency siren' and 'testing' shall be very much different from each other, so that the same could be differentiated clearly.

iv) Vendor shall specifically confirm that communication shall be clear and audible even in noisy areas. If any adjustments in amplifier system etc. required in this connection at site during and after commissioning the same shall be done without any extra cost to the Purchaser.

5. DUAL CHANNEL POWER AMPLIFIERS:

The dual channel power amplifiers shall have the following features:

a. Power output: 150 W per channel at 0.05 % harmonic distortion over frequency range 40 to 20,000 Hz + 1 dB.

b. Frequency response 40 to 20,000 Hz + 1 dB at specified power.

c. Signal and noise level: 100 dB below rated output.

d. Channel separation: 90 dB at 1 kHz.

e. Output: 100V / 70 V.

f. Controls and indicators such as volume control, AC power switches etc.

6. POWER SUPPLY :

Power supply unit shall be well filtered, regulated, have constant voltage under load and shall have the following additional features:

a. Output: 24, 12 V dc.

b. Input: 120 V, 60 Hz, nominal.

c. Power consumption: as required.

d. Replaceable fuse: as required.

e. Rectifier: silicon full wave bridge.

f. Filter, choke and dual condensers.

g. Hook-up (+) (-) terminals strip with terminal screws.

h. Line cord: 2 m (6ft.), 3 (three) conductor with strain relief.

7. GOOSE NECK MICROPHONES:

Microphones shall be hand held type, table mounted, close talking, noise canceling, low impedance. Dynamic type, complete with goose neck and have the following features:

i) Frequency response: 50 - 15,000 Hz.

ii) Output level: approximately - 55 dB

iii) Sensitivity: - 149dB

iv) Output impedance, balanced to ground, 150 ohms.

v) Housing, metal, desk, flexible goose neck, black finish.

vi. Built-in push -to-talk switch.

vii) Magnetic dust shield.

SPEAKER AND CABLES:

The ceiling ring speaker shall be double cone Loudspeaker attached to a circular grille which is injection molded from high impact polystyrene. The assembly shall be secured in to cut-out, using two integral spring loaded ceiling locking clamps. The Loudspeaker shall be supplied with transformer with winding taps that allow outputs of 3 W, 6 W or 15 W.

Make		**Bidders Data**
Power Handling Capacity	:	6 W
Sound Pressure Level	:	64 dB
Nominal Voltage	:	100 V / 70 V (tap)
L.S. impédance	:	4 Ohms.
Dimensions	:	

Colour	:	
Make		
Power Handling Capacity	:	15 W
Sound Pressure Level	:	96 dB
Nominal Voltage	:	100 V / 70 V (tap)
L.S. impédance	:	4 Ohms.
Dimensions	:	
Colour	:	

SPEAKER CABLES:

i) Cable Type	:	Signal
	:	Armored FRLS
	:	Multistrand Conductors
	:	Twisted pair
ii) Conductor	:	Conductor dia - 0.2mm
	:	No. of Strands - 24
	:	ATC
	:	Resistance per Km. (Max. 25 Ohms)
iii) Individual Insulation		:PVC Type as per IS - 5831
	:	Insulation Thickness nominal : 0.5mm
iv) Total Cores	:	No. of Pairs 1 (One) laid in sequence
	:	Colour code: Red - Black
v) Overall Sheath	:	Thickness - 1.8mm
	:	Material - PVC type as per IS - 5831
	:	Outer dia - 8.5mm dia

SPECIFICATION FOR WIRING

Prior to laying and fixing of conduits, the contractor shall carefully examine the drawings indicating the layout, satisfy himself about the sufficiency of number and sizes of conduits, sizes and location of conduits and other relevant details. Any discrepancy found in the drawings shall be brought to the notice of Consultant / Project Manager. Any modifications suggested by the Contractor shall be got approved by the Consultant / Project Manager before the actual laying of conduits is commenced.

All cables from various zones to be terminated on termination box & from there individual cables will connect to the amplifier system.

7. TESTING

7.1 GENERAL

At the completion of the work, the entire installation shall be subject to the following tests in the presence of the Owner's site representative.

Wiring continuity test.
Insulation resistance test.
Earth continuity test.
Earth resistivity test.
Test as per Appendix `E' of IS:732 -1989

Besides the above, any other test specified by the local authority shall also be carried out. All tested and calibrated instruments for testing, labour, materials and incidentals necessary to conduct the above tests shall be provided by the Contractor at his own cost.

7.2 TESTING OF WIRING

All wiring systems shall be tested for continuity of circuits, and earthing after wiring is completed and before installation is energized.

7.3 INSULATION RESISTANCE TEST

The insulation resistance shall be measured between earth and the whole system of conductors, or any section thereof, with all switches closed and except in concentric wiring all lamps in position of both poles of the installation otherwise electrically connected together, a direct current pressure of not less than twice the working pressure provided that it does not exceed 660 volts for medium voltage circuits. Where the supply is derived from AC three phase system the neutral pole of which is connected to earth, either direct or through added resistance, pressure shall be deemed to be that which is maintained between the phase conductor and the neutral. The insulation resistance measured as above shall not be less than 50 divided by the number of points provided on the circuit, the whole installation shall have an insulation resistance greater than one mega-ohms. The insulation resistance between the frame work of housing of power appliances and all live parts of each appliance shall not be less than that specified in the relevant standard specification or where there is no such specification, shall not be less than one a mega-ohms. All equipments, cables shall be inspected at works by the Architect as per relevant IS and testing commissioning of installation as per Appendix `E' of IS: 732-1989 shall be done and all record to be maintained.

7.4 TESTING OF EARTH CONTINUITY PATH

The earth continuity conductor metallic envelopes of cables shall be tested for electric continuity and the electrical resistance of the same, along with the earthing lead but excluding any added resistance or 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.

7.5 TESTING OF POLARITY OF NON-LINKED SINGLE POLE SWITCH

In a two wire installation a test shall be made to verify that all non-lined single pole switches have been connected to the same conductor throughout, and such conductor shall be labeled or marked for connection to an outer or phase conductor or to the non-earthed conductor of the supply. In the three or four wire installation, a test shall be made to verify that every non-linked single pole switch is fitted to one of the outer or phase conductor of the supply. The entire electrical installation shall be subject to the final acceptance of the Owner's site representative as well as the local authorities.

7.6 INSTALLATION OF FIRE ALARM INITIATING AND INDICATING DEVICES

a. Fire Alarm Control Panel(FACP) : The FACP shall be fixed as indicated on the drawings the enclosure with the top of the cabinet 1830 mm 6 feet above the finished floor or center the cabinet at 1525mm or 5 feet, whichever is lower. Conductor terminations shall be labeled and a drawing containing conductors, their labels, their circuits, and their interconnection shall be permanently mounted in the FACP.

b. Manual Stations: The Manual stations shall be fixed as required by NFPA 101 and NFPA 72 or as shown on the drawings or in accordance with client's Engineer. Mount stations so that their operating handles are 1220 mm 4 feet above the finished floor. Mount stations so they are located no farther than 1525 mm 5 feet from the exit door they serve, measured horizontally.

c. Notification Appliance Devices: Notification appliance devices shall be fixed as required by NFPA 72 or as shown on the drawings. Mount assemblies on walls 2030 mm 80 inches above the finished floor or 150 mm 6 inches below the ceiling whichever is lower. Ceiling mounted speakers shall conform to NFPA 72.

d. Smoke and Heat Sensors: Sensors shall be fixed as required by NFPA 72 and their listings or as shown on the drawings on a 100x100mm inch mounting box. Sensors located on the ceiling shall be installed not less than 100 mm 4 inches from a side wall to the near edge. Those located on the wall shall have the top of the sensor at least 100 mm 4 inches below the ceiling, but not more than 300 mm 12 inches below the ceiling. In raised floor spaces, the smoke sensors shall be installed to protect 20.9 square meters 225 square feet per sensor. Install smoke sensors no closer than 1525 mm 5 feet from air handling supply outlets.

e. Graphic Annunciator: Locate the graphic annunciator as shown on the drawings. Surface mount the panel, with the top of the panel 1830 mm 6 feet above the finished floor or center the panel at 1525 mm or 5 feet, whichever is lower.

f. Water Flow Detectors and Tamper Switches: Locate water flow detectors and tamper switches where shown on the drawings at each supervised sprinkler valve station.

g. Firefighter Telephones: Locate wall mounted in each stair at each floor landing, in each elevator lobby, and in each elevator cab 1220 mm 4 feet above the finished floor.

7.7 FIELD QUALITY CONTROL

Tests

a. Megger Tests: After wiring has been installed, and prior to making any connections to panels or devices, wiring shall be megger tested for insulation resistance, grounds, and/or shorts. Conductors with 300 volt rated insulation shall be tested at a minimum of 250 VDC. Conductors with 600 volt rated insulation shall be tested at a minimum of 500 VDC. The tests shall be witnessed by the Contracting Officer and test results recorded for use at the final acceptance test.

b. Loop Resistance Tests: Measure and record the resistance of each circuit with each pair of conductors in the circuit short-circuited at the farthest point from the circuit origin. The tests shall be witnessed by the Contracting Officer and test results recorded for use at the final acceptance test.

c. Preliminary Testing: Conduct preliminary tests to ensure that devices and circuits are functioning properly. Tests shall meet the requirements of paragraph entitled "Minimum System Tests." After preliminary testing is complete, provide a letter certifying that the installation is complete and fully operable. The letter shall state that each initiating and indicating device was tested in place and functioned properly. The letter shall also state that panel functions were tested and operated properly. The letter shall include the names and titles of the witnesses to the preliminary tests. The Contractor and an authorized representative from each supplier of equipment shall be in attendance at the preliminary testing to make necessary adjustments.

d. Request for Formal Inspection and Tests: When tests have been completed and corrections made, submit a signed, dated certificate with a request for formal inspection and tests to the Contraction Officer.

e. Final Testing: Notify the Contracting Officer in writing when the system is ready for final acceptance testing. Submit request for test at least 15 calendar days prior to the test date. A final acceptance test will not be scheduled until the operation and maintenance (O&M) manuals are furnished to the Contracting Officer and the following are provided at the job site:

i. The systems manufacturer's technical representative

ii. Marked-up red line drawings of the system as actually installed

iii. Megger test results

iv. Loop resistance test results

v. Complete program printout including input/output addresses

The final tests shall be witnessed by the Fire Protection Engineer deputed by the client or as instructed by project in charge. At this time, any and all required tests shall be repeated at their discretion. Following acceptance of the system, as-built drawings and O&M manuals shall be delivered to the Contracting Officer for review and acceptance.

7.8 **MINIMUM SYSTEM TESTS**

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. All testing shall be in accordance with NFPA 72, Chapter 7.

a. Verify the absence of unwanted voltages between circuit conductors and ground. The tests shall be accomplished at the preliminary test with results available at the final system test.

b. Verify that the control unit is in the normal condition as detailed in the manufacturer's O&M manual.

c. Close each sprinkler system flow valve and verify proper supervisory alarm at the FACP.

d. Verify activation of all waterflow switches.

e. Open initiating device circuits and verify that the trouble signal actuates.

f. Open and short signaling line circuits and verify that the trouble signal actuates.

g. Open and short notification appliance circuits and verify that trouble signal actuates.

h. Ground all circuits and verify response of trouble signals.

i. Check presence and audibility of tone at all alarm notification devices.

j. Check installation, supervision, and operation of all intelligent smoke detectors using the walk test.

k. 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.

l. Test each initiating and indicating device and circuit for proper operation and response at the control unit. Smoke sensors shall be tested in accordance with manufacturer's recommended calibrated test method. Testing of duct smoke detectors shall comply with the requirements of NFPA 72.

m. Test the system for specified functions in accordance with the contract drawings and specifications and the manufacturer's O&M manual.

n. Test both primary power and secondary power. Verify, by test, the secondary power system is capable of operating the system for the time period and in the manner specified.

o. Determine that the system is operable under trouble conditions as specified.

p. Visually inspect wiring.

q. Test the battery charger and batteries.

r. Verify that software control and data files have been entered or programmed into the FACP. Hard copy records of the software shall be provided to the Contracting Officer.

s. Verify that red-line drawings are accurate.

t. Measure the current in circuits to ensure there is the calculated spare capacity for the circuits.

u. Measure voltage readings for circuits to ensure that voltage drop is not excessive.

v. Disconnect the verification feature for smoke sensors during tests to minimize the amount of smoke needed to activate the sensor. Testing of smoke sensors shall be conducted using real smoke. The use of canned smoke is prohibited.

w. Measure the voltage drop