TECHNICAL SPECIFICATION
FOR
CIVIL WORK

TECHNICAL SPECIFICATIONS FOR CIVIL WORK

PREAMBLE TO SPECIFICATIONS

The conditions of contract and the drawings shall be read in conjunction with the specifications and matters referred to, shown or described in one are not necessarily repeated in the other. These specifications are comprehensive and may exceed the requirements of this project. Any ambiguity between the General Specifications, the Bill of quantities and contract drawings, shall be referred to the Consultant for clarification not later than 10 days before the date fixed for delivery of Tenders. Any ambiguity may be referred to the Consultant after signing of the contract and Consultant shall give a ruling which shall prevail. No claim for additional cost due to above, however, will be entertained.

Notwithstanding the sub-division of the specification into various headings, every part of it is to be deemed supplementary to every other part and is to be read with it, so far as it may be practicable so to do, or when the context so admits.

In this contract, reference is made to the Indian Standards and these references shall be deemed to include the latest editions or issue of standards, specifications or By-Law including all revisions upto the date of invitation of Tenders. The contractor shall ensure that all materials and workmanship in so far as they apply to this contract shall comply in every specifications or any other equivalent or specification approved by the Consultant.

The Contractor shall keep at site copies of all relevant standards and codes of practice referred in these specifications throughout the period of contract. These shall be the latest editions and shall include all revisions/addendums thereof.

Approved Manufacturers: Names of approved manufacturers are given in the specifications.

Reference in the specifications to approved manufacturers shall be construed as establishing a standard of quality and not as limiting competition.

The Contractor shall include in his prices for supplying the item or materials from the approved manufacturers listed or equal and approval.

All items or materials shall be delivered to the site in the manufacturers original unopened containers with the manufacturers brand and name clearly marked on.

All items or materials shall be assembled, mixed, fixed, applied or otherwise incorporated in the works in accordance with the printed instructions of the manufacturer of the item or materials.

Contractor shall mix all mortar and concrete by way of mechanical means and measurement boxes of standard size to be used for measuring coarse/fine aggregate.

Date of construction to be written on all respective items for monitoring curing.

Contractor shall follow the pour card/check list for all the concrete/finishing items.

1.0 GENERAL

1.1 Scope

This specification applies to the Civil Engineering and building works to be executed by the Contractor. It is to be read in conjunction with and subject to the general conditions of contract and in conjunction with the drawings, the schedule of rates and such other documents as may from time to time be agreed upon as comprising part of this contract. Where these specifications are not clear**, CPWD specifications shall be followed**.

1.2 Clearing

The contractor shall clear the site of all rubbish and old buildings, remove all grass and low vegetation and remove all bush wood, trees, stumps of trees, and other vegetation only after consultation with the Architect/Project Managers as to which bushes and trees shall be saved. All disused foundations, drains or other obstructions met with during excavation shall be dug out and cleared.

1.3 Site Levels

The contractor shall carry out the survey of the site and shall establish sufficient number of grids and level marks to the satisfaction of the Architect/Project Manager, who shall decide on the basis of this information, the general level of the plot and the plinth.

1.4 Bench-marks

Prior to commencement of construction, the contractor shall in consultation with the Engineer, establish several site datum benchmarks, their number depending on the extent of the site. The benchmarks shall be sited and constructed so as to be undisturbed throughout the period of construction.

1.5 Site investigation

The Architect/Project Manager might have got the soil investigation done and if so, the report will be handed over to the contractor for their scrutiny. The contractor shall however inspect the site and study the findings from the trial pits or bores in order to assess the problems involved in and methods to be adopted for excavation and earth work. The contractor shall ascertain for himself all information concerning the sub-soil conditions, Ground water table periods and intensity of rainfall, flooding of the site and all data concerning excavation and earthwork.

1.6 Setting out the work

The contractor shall set out the works and during the progress of the building shall amend at his own cost any errors arising from inaccurate setting out.

During the execution of the work contractor must cross check his work with the drawings. The contractor shall be responsible for all the errors in this connection and shall have to rectify all defects and/or errors at his own cost, failing which the Architect/Project Manager reserves the right to get the same rectified at the risk and cost of the contractor.

1.7 Cleaning up and handing over

Upon completion of the work all the areas should be cleaned. All floors, doors, windows, surface, etc. shall be cleaned down in a manner, which will render the work acceptable to the Architect and Employer. All rubbish due to any reason, shall be removed daily from the site and an area of up to ten meters on the outer boundaries of the premises will be cleaned by the contractor as a part of the contract. Upon completion of the project, the contractor shall turn over to the employer the following:

a) Written guarantee and certificates.
b) Maintenance manuals, if any, and
c) Keys.

1.8 Samples

The contractor shall submit to the Architect/Project Managers samples of all materials for approval and no work shall commence before such samples are duly approved. Samples of precast concrete panels, masonry units, building insulation, finished hardware, metal window and door frames, Vitrified tiles, Ceramic tile , kota stone, Granite/marble stone etc. and every other work requiring samples in the opinion of the Architect/Project Managers shall be supplied to the Architect/Project Managers, and these samples will be retained as standards of materials and workmanship. The cost of the samples shall be borne by the contractor.

Throughout this specification, types of material may be specified by manufacturers' name in order to establish standard of quality, price and performance and not for the purpose of limiting competition. Unless specifically stated otherwise, the tenderers may assume the price of 'approved equivalent' except that the burden is upon the contractor to prove such equality, in writing.

A detailed program shall be submitted by the Contractor for the material approvals, within four weeks of the Architect/Project Managers' order to commence. The detailed program shall include but not limited to:

Date/s of submitting the various material samples.

Date/s by which the Architect/Project Managers' approval is required.

Date/s of placing orders on the Manufacturers/Suppliers.

Date/s of arrival of the approved material/s on to the site.

Date/s of the completion of the `Mock-ups', wherever required, and the Date/s by which the Architect/Project Managers' inspection of such `Mock-ups' should be completed and the Date/s by which the Architect/Project Manager should fully approve the said Mock-ups.

1.9 Tests

All materials and methods of tests shall conform to the latest rules, regulation and/or specifications of the following authorities where specified herein as applicable. Bureau of Indian Standards (BIS), British Standards Code of Practice (BS) in case no equivalent BIS is available. The Architect/Project Managers will have the option to have any of the materials tested and if the test results show that the materials do not conform to the specifications, such materials shall be rejected. A reasonable number of representative tests will be deemed to be included in the rates tendered.

1.10 Rates

The item rates quoted in schedule of quantities are deemed to be included to execute the works in strict accordance with the relevant specifications read in conjunction with the appropriate Standard Specifications.

1.11 Mode of Measurements

All measurements will be taken in accordance with IS 1200 latest issue unless otherwise specified.

2.0 EARTH WORK

2.1 General

This specification deals with the clearance of the Site of Works and preparation of the same to commence the proposed construction activities. Wherever applicable, this is deemed to include all preliminary works like Dismantling/Demolition, Site Clearance, and General Leveling etc.

The contractor shall visit the site, inspect the same and decide for himself the nature of the ground and the sub-soil to be excavated. No claim on account of extras will be entertained in consequences of any misunderstanding or incorrect information or **ignorance's of the existing** conditions.

Lead : All distances shall be measured over the shortest practical route and not necessarily the route actually taken. Route other than shortest practical route may be considered in cases of unavoidable circumstances and approved by the Project Engineer.

Lift : The vertical distance for removal with reference to ground level. The excavation up to 1.5 meters depth below ground level and depositing the excavated materials up to 1.5 meters above ground level are included in the rate of earth work. Lifts inherent in the lead due to ground slope shall not be paid for.

2.2 Dismantling/Demolition

Existing Buildings and structures within the boundary of the site, and as indicated in the drawings or as instructed by the Architect/Project Manager, shall be carefully and gradually dismantled or demolished, as the case may be.

i) The contractor shall furnish to the Architect/Project Manager, a detailed scheme as well as a program of these works, at least one week prior to the commencement of the actual demolition works and get the laters approval of the same.

ii) On approval of the above program and scheme, the contractor shall serve notices to concerned authorities, owners, etc. as and wherever applicable, informing them of the proposed demolition and get their approval of the same, prior to the demolition/dismantling.

iii) The whole of the building/structures that are to be demolished shall be evacuated and cleared off any valuable life and/or property to the satisfaction of the Architect/Project Manager. Where required, the employer shall provide alternative arrangements to house those who have been evacuated.

iv) The site of demolition shall be well cordoned off from the other areas to the satisfaction of the Architect/Project Manager, with all necessary warning and signals, erected in the vicinity by the Contractor.

v) Such of those parts of the building/structures that are likely to fetch some returns from the market and/or those parts which are likely to be reused elsewhere, shall be first carefully removed from the existing buildings and then stored away properly to the complete satisfaction of the Architect/Project Manager. Such parts shall include items like wood work, built in furniture, electrical fittings, sanitary wares etc. and all others that are listed out by the Architect/Project Manager.

vi) The demolition work shall then commence preferably from the top and proceed downwards, gradually. In case of buildings comprising more than one floor, the demolition shall commence from top and shall be dismantled

floor by floor in such a way that all the debris are collected in the next lower floor. Dismantling of external walls/cladding shall be done from outside inwards. The dismantling of the next lower floor shall commence only after the clearance of all debris collected in that floor from the floor above, is completed.

All dismantling/demolition works shall include excavation of the ground, wherever necessary, to dismantle the existing foundations, and back filling, including compacting to the satisfaction of the Architect/Project Manager. The material used for back filling shall be as per specifications and as approved by the Architect/Project Manager.

All dismantling/demolition works shall be carried out in such a manner, so as not to cause any damage, whatsoever, to the properties or persons in the vicinity of the site. If such damages occur, the contractor shall be liable for full reinstatement, of all such damages, at his own cost.

All services, like electrical, water supply and sanitary lines/ connections, to the existing buildings or structures that are to be dismantled and/or demolished, shall be properly cut off at points as per the instructions of the Architect/Project Manager. If any such service lines are feeding adjacent plots/ sites/premises as well as within the premises, the contractor shall inform the Architect/Project Manager, well in advance, and shall follow up with the Authorities concerned, to provide necessary reconnections to the users of these service lines.

Wherever applicable, the contractor shall apply for the various permits, for executing such works as may be required, from the relevant authorities.

Disposal of demolished/dismantled materials

Demolished/dismantled materials shall **NOT** be stacked or dumped in such a manner, as to present a hazard to vehicles or pedestrians or properties or to cause blockage in drainage channels etc.

The contractor shall obtain necessary permission from the local Government Authorities, pay the necessary deposits, for the location and the manner in which the debris to be disposed and then carry out the disposal, as directed by the Architect/Project Manager.

Demolished/Dismantled debris shall be dumped/stacked in an area, primarily within the site, if required, subject to the approval of the Architect/Project Manager and shall cart away and dispose off, within the shortest possible time, as directed by the Architect/Project Manager.

All dismantling works shall be carried out by crow bar, chiseling or by Jack - Hammering but in no case blasting operation is permitted at site.

All debris shall be transported from the site on daily basis during prescribed hours as approved by local authorities for transportation.

2.3 Classification of Soils

The earth shall be classified under the following categories and measured separately for each category:

2.3.1 Authority for classification of Soils/Rocks

The classification of excavation shall be decided by the Architect/Project Manager and his decision shall be final and binding on the contractor.

2.3.2 Trimming of Slopes

All slopes shall be trimmed by hand or mechanically true to line and profile and consolidated to the Architect/Project Managers' satisfaction. Any rock or

boulders appearing on the face or likely to be unstable, shall be removed and the void thereof filled with approved material and compacted.

2.3.3 Shoring/Earth work support

The contractor shall shore and strut the sides of excavation to the satisfaction of the Architect/Project Manager. Should there be any slips or settlement, not withstanding the shoring, the contractor shall make good the same at his own expense, with concrete or other approved material, as directed by the Architect/Project Manager. Shoring shall be removed gradually side by side with backfilling to prevent any settlement and under no circumstances, until such time as the foundation concrete has hardened enough, to take any loads brought on by the removal. Under special circumstances, shoring shall be left in place, if so directed by the Architect/Project Manager. No extra payment shall be made for shoring. The rate for the same shall be included in the excavation items.

2.3.4 Dewatering

All excavation shall be kept free from water from any source. The contractor shall provide and clear away on completion, all drains, pumps and other Equipment, for this purpose. The contractor shall be responsible for preventing any subsidence of adjoining ground due to pumping.

Contractor shall keep site dewatered till all construction works in basement and other areas are completed, including waterproofing. No extra amount shall be claimed by the contractor on this account and his quoted rates shall be deemed to have been included for total dewatering, including sub-soil water also.

2.3.5 Contractor to keep excavation clear

Should any sand, mud, weed, rubbish or other materials be deposited on excavated area, by sandstorm, rain, flood, landslips or from any cause, whatsoever, such materials shall be removed by the contractor at his own Expense.

2.3.6 Backfilling

All materials used as fill shall be to the Architect/Project Managers' approval. Filling materials shall be well graded clean stone, Gravel and other approved non-plastic granular material, all not more than 100 mm, in any direction and shall be well compacted in layers not more than 150mm thick. Final compaction must be done just before concrete is to be laid.

All fill materials shall be compacted at moisture content appropriate to the material being used. The compacted filling shall achieve a density, which shall not be less than 95% of the maximum dry density obtained. Filling shall be free of any wood, organic matter or any other deleterious material.

Each compacted layer shall be tested in the field for density and accepted before the operations for next layer are begun.

Density Measurement and Acceptance Criteria.

One measurement of density shall be made for each 500 sqm of compacted area or for a smaller area as decided by the Engineer-in-charge. Each measurement shall consist of atleast 5 density determinations and the average of these 5 determinations shall be treated as the field density achieved. The determination of density shall be as per IS: 2720 (Pt. XXVIII).

Soil, moorum, grand a mixture of these or any other material approved by the Engineer.

Expansive clay inhibiting marked small and shrinkage properties shall not be used as fill material.

In case the excavated materials are not approved for backfilling, either totally or in part or if their quantity falls short of the quantity required for filling, suitable materials shall be brought to site from an approved source. The material should be free of all shrubs, vegetation, tree cutting before restoring.

2.3.7 Disposal of surplus material

Surplus excavated materials and all excavated materials rejected for backfilling shall be carted away from the site by the Contractor at his own cost.

2.3.8 Measurements

i) Where excavation is in trenches or from borrow pits in a firmly uniform ground, measurements of cutting in trenches or borrow pits shall be made to the outer line of building wall.

ii) Diagonal ridges, cross ridges, or dead man shall be left in position shown by the Architect/Project Manager to enable accurate measurements being taken on the completion of one work. Where the ground is not uniform or where the site is required to be leveled, levels shall be taken before the start of the work and after the completion of the work and the quantity of excavation in cutting computed from these levels. These ridges or deadman shall be removed by the Contractor at his own cost after the measurements.

iii) Where soil, soft rock, and hard rock are mixed, the measurements for the entire excavation shall be computed from the levels as described (ii) above.

iv) Excavated materials from `HARD ROCK' and SOFT ROCK shall be stacked separately, measurement reduced by 50% to allow for voids to arrive at the quantity payable under 'hard rock' and 'soft rock' respectively.

v) The difference between the entire excavation (worked out from the levels) and the such of the quantities payable under 'hard rock' and 'soft rock' shall be paid for as excavation in all kind of soil.

vi) Wherever rock excavation is encountered, contractor will be paid only up to required level, and any extra excavation if carried out due to any reason, no payment shall be done for the extra quantity.

2.4 Excavation in all Soils

Excavation and/or removal of any other material on the site, shall be carried out accurately to the lines, levels and dimensions shown in the drawings or as ordered by the Architect/Project Manager, so as to allow proper and efficient concrete work and other work in clean and dry condition. The method of excavation shall be at the discretion of the Architect/Project Manager but should the dimensions of any excavation exceed those shown on the drawings or ordered by the Architect/Project Manager or should the sides collapse, the contractor shall fill such extra space with concrete or other approved material, at his own expenses.

All founding levels will be inspected by the Architect/Project Manager and suitability for bearing of the bottom shall be determined before the concrete is placed. Records of all foundation levels shall be submitted by the contractor to the Architect/Project Manager.

The final 150 mm depth of excavation shall be taken out by hand unless otherwise permitted by the Architect/Project Manager. Extra depth of excavation, if any, beyond those shown in the drawings or ordered by the Engineer, shall be filled up with Grade 10 concrete for which payment shall not be made.

The contractor shall excavate any soft patches or rock outcrops below the founding level and refill with M-10 concrete. The founding stratum shall be trimmed to required level and rammed to the satisfaction of the Architect/Project Manager before concrete is placed.

Foundations within any one building shall not rest on soil strata with differential bearing capacities. Strip foundations shall not be stepped along the length of the foundations. When excavating for individual footings at different levels care shall be taken not to disturb the bearing stratum of the higher foundations. The excavation bottom shall be watered as directed by the Architect/Project Manager before the foundations are laid.

2.5 Sweet Earth

The Sweet earth for plantation areas, shall be from an approved source and shall be mixed with natural or artificial manure, as directed by the Architect/Project Manager.

2.6 Polythene layer

Wherever directed, all concrete pours resting directly over prepared soil or hard-core, shall be placed over "Shivathene/ SIL of or equivalent, heavy polythene sheeting of thickness given in BOQ . All joints in the sheeting shall be double welt folded joints, made by placing the edges together and folding over twice.

The folds shall be held in place by placing temporary weights and the sheets will be protected from damage during concreting operations. All damaged sheets will be replaced. Where necessary, the polythene film shall be returned to overlap the damp proof course in walls.

2.7 Pre-construction Anti-termite treatment

i) Chemicals

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

Chemicals (EC's)	Concentration
Chlorpyriphos 20 % EC1 % (Pyramid or equivalent) Durmat	By weight

Chemicals are available in concentrated form in the market and concentration is indicated on the sealed containers. To achieve the percentage of concentration specified above, chemical should be diluted with water in required quantity before it is used. Graduated containers shall be used for dilution of chemical with water in the required proportion to achieve the desired percentage of concentration. e.g. to dilute chemical of 30% concentration add 59 parts of water to one part of chemical to achieve 0.5% concentration.

Chemical shall be brought to site of work in sealed original containers. The material shall be brought in at a time in adequate quantity to suffice for the whole or at least a fortnight's work. The materials shall be kept in the joint custody of the contractor and the Architect/Project Manager/ Representative. The empties shall not be removed from the site of work, till the relevant item of work has been completed and permission obtained from Architect/Project Manager/his representative. The empties shall not be removed from the site of work, till the relevant item of work has been completed and permission obtained from the Architect/Project Manager/his representative.

Hand operated pressure pump shall be used to carry out spraying operations to facilitate proper penetration of chemicals in the earth. 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.

ii) Time of application

Soil treatment should start when foundation trenches and pits are ready to take mass concrete in foundations. Laying of mass concrete should 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 soil is wet with rain or sub-soil water. The foregoing applies also in the case of treatment to the filled earth surface with the plinth before laying the sub grade for the floor.

The treated soil barrier 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.

iii) Treatment for masonry foundation and basements

The bottom surface and sides (up to a height of 30 cm. from the bottom) of the excavations made for masonry foundations and basements shall be treated with the chemical emulsion mentioned above at 5 Ltrs. per Sq.m. of surface area.

iv) Treatment to backfill earth

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

v) Treatment for RCC foundations

The treatment described in (iii) & (iv) above applies essentially to masonry foundations where there are voids in the masonry through which termites can seek entry in to the superstructure. Hence the foundation requires to be completely enveloped by a chemical barrier. In the case of RCC foundations the concrete is dense being a 1:2:4 mix or richer, the termites are unable to penetrate it. It is therefore unnecessary to start the treatment from the bottom of excavations. The treatment shall start at a depth of 50 cm. below the ground level except when ground level is raised or lowered by filling or cutting after the foundations have been cast. In such cases the depth of

50 cm shall be determined from the new soil level resulting from filling or cutting mentioned above and soil in immediate contact with the vertical surface of RCC foundations. From this depth, the back fill around the columns, beams and RCC basement walls shall be treated at the rate of 7.5 Ltrs. per Sq.m. The other details of the treatment shall be as laid down in (iv) above.

vi) Treatment of top surface of plinth filling

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

vii) Treatment at junction of walls and floor

Special care shall be taken to establish continuity of the vertical chemical barrier on inner wall surfaces from the ground level (where it has stopped with the treatment described in (iv) above up to the level of the filled earth surface. To achieve this, a small channel 3 x 3 cm shall be made at all the junctions of wall and columns with the floor (before laying the subgrade)

and rod holes made in the channel up to the ground level 15 cm. apart and the rod moved back ward and forward to break up the earth and chemical emulsion poured along the channel at the rate of 7.5 Ltrs. per Sq.m. of the vertical wall or column surface of the sub structure so as to soak the soil right to the bottom. The soil should be tamped back in to place after this operation.

viii) Treatment to soil along external perimeter of building

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

ix) Treatment for walls retaining soil above floor level

Retaining walls like the basement walls or outer walls above the floor level retaining soil need to be protected by providing chemical barrier by treatment of retained soil in the immediate vicinity of the wall, so as to prevent entry of termites through the voids in masonry, cracks and crevices etc. above the floor level. The soil retained by the walls shall be treated at the rate of 7.5 Ltrs. per sq.m. of the vertical surface so as to effect a continuous outer chemical barrier in continuation of the one formed under (iii).

x) Treatment of soil under apron along external perimeter of building

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

xi) Treatment of soil surrounding pipes, wastes and conduits

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

xii) Treatment for expansion joints

Expansion joints at ground floor level are one of the biggest hazards for termite infestation. The soil beneath these joints should receive special attention when the treatment under (V) is carried out. This treatment should be supplemented by treating through the expansion joint after the subgrade has been laid, at the rate of 2 Litre per linear metre.

xiii) Safety precautions

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, in haled 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:

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 pet cannot get at them. They should be kept securely closed.

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 in to the eyes they shall be flushed with plenty of soap and 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 during mixing.

Care should be taken in the application of chemicals to see that they are not allowed to contaminate wells or springs which serve as sources of drinking water.

xiv) Spraying equipment

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

xv) Measurements

All dimensions shall be measured correct to a cm. The measurements for all the operations described above shall be the plinth area of the building in square-meters at floor 1 level (Ground Floor). Nothing extra shall be measured for payment.

xvi) Rate

The rate for the anti-termite treatment shall include the cost of labor, material and all other inputs involved in all the operations described above.

3.0 CONCRETE WORKS

3.1 All concrete included in the works shall comply with the General requirements of this section of the specification except where those requirements are modified by the provisions of later Clauses relating to specialized uses for concrete in which case the requirements of those Clauses shall take precedence.

3.2 Supervision

A competent person shall be employed whose first duty will be to supervise all stages in the preparation and placing of the concrete. All test of materials, the making and testing of cubes and the maintenance and calibration of all mixing and measuring plant shall be carried out under his direct supervision.

3.3 Materials

a) Cement

i) Types

The cement used shall be ordinary port land cement conforming to IS 8112 (Latest revision) of grade 43 for all works except where specifically mentioned in the Drawings, Bill of Quantities, and/or directed by the Architect/Project Manager.

All cement shall be fresh when delivered. Cement shall be delivered in sound and properly secured bags or other packages ready for immediate use and shall be used direct from the bag. The contractor shall maintain for

Architect/Project Managers' inspection a record of receipts and consumption of cement indicating the source, the age and the date of receipt of cement. Cement containing lumps which cannot be broken by a light touch of fingers shall not be used in the works. Admixtures shall not be used without written consent of the Architect/Project Manager.

ii) Sources

Cement shall be obtained from sources which are approved by the Architect/Project Manager. Makes and sources of cement shall not be varied from those used for trial mixes; should a change be unavoidable the contractor shall submit his proposals for the prior approval of the Architect/Project Manager and then carry out new trial mixes unless otherwise directed by the Architect/Project Manager. Cement of different kinds shall not be mixed at any stage.

iii) Manufacturers' Test Certificates for Cement

The Contractor shall request the cement manufacturer to forward to his site office the Certificate of conformity in accordance with IS. 8112 (Latest Revision), and he shall cause a copy to be supplied to the Architect/Project Manager within 48 hours of the arrival of the certificate, which shall not be later than 14 days from the day of delivery of the relevant consignment. The test certificate shall be related to the date of delivery at site of consignment. The frequency of deliveries shall be such as to ensure that no cement is more than 4 months old when used in the works.

iv) Samples of Cement

Samples of cement to be used in the works shall be deposited with the Architect/Project Manager for his approval together with a certificate stating the name and address of the Manufacturer, the name and address of the supplier from whom it was purchased. The Architect/Project Manager may from time to time take samples of the cement being used in the works for testing.

v) Storage of Cement

The contractor shall provide a proper separate weatherproof store building with raised floor for cement on the site and shall at all times protect the cement from damp or any other deleterious influences. Each consignment of cement shall be kept separately and the contractor shall be careful to ensure the consignments are used in the order in which they are received.

b) Aggregates

i) Materials used as aggregates shall be obtained from a source known to produce aggregates satisfactory for concrete and shall be chemically inert, strong, hard, durable, of limited porosity and free from adhering, coating, clay lumps, coal residues and organic or other impurities that may cause corrosion of reinforcement or may impair the strength or durability of the concrete. Aggregates shall be tested in accordance with the requirements of IS. 383 or IS. 515 and the results of such tests shall be as hereinafter specified, the percentages being by weight unless the context indicates otherwise.

ii) Coarse aggregate shall consist of clean, hard, strong, dense, not-porous and durable pieces of crushed stone, crushed gravel, natural gravel or a suitable combination thereof or other approved inert material. They shall not consist pieces of disintegrated stones, soft, flaky, elongated particles, salt, alkali, vegetable matter or other deleterious materials in such quantities as to reduce the strength and durability of the concrete, or to attack the steel reinforcement. Coarse aggregate having positive alkali silica reaction shall not be used. All coarse aggregates shall conform to IS:383 and tests for conformity shall be carried out as per IS:2386 Parts I to VIII.

Fine aggregate shall consist of clean, hard, strong and durable pieces of crushed stone, crushed gravel, or a suitable combination of natural sand,

crushed stone or gravel. They shall not contain dust, lumps, soft or flaky, materials, mica or other deleterious materials in such quantities as to reduce the strength and durability of the concrete, or to attack the embedded steel. Motorized sand washing machines should be used to remove impurities from sand. Fine aggregate having positive alkali-silica reaction shall not be used. All fine aggregates shall conform to IS : 383 and tests for conformity shall be carried out as per IS:2386, (Part I to VIII)

iii) Coarse Aggregate

Size of coarse aggregate shall be maintained within tolerance limit of 2.5%.

The grading of coarse aggregate shall be such that not more than 5% shall be larger than 20 mm and not more 10% shall be smaller than 5 mm and not less than 25% or more than 55% shall be smaller than 10 mm.

Maximum size of coarse aggregate shall be of 20 mm unless otherwise noted.

The grading of coarse aggregate of nominal size of 40 mm shall be such that not more than 5% shall be larger than 40 mm and not more than 5% shall be smaller than 5 mm and not less than 10% or more than 35% shall be of 10 mm size.

Aggregate (Fine and Coarse) shall be thoroughly washed with clean water if so directed by the Architect/Project Manager.

Fragile, flaky and laminated pieces, and mica shall not be present. Aggregate should be free from fine holes and stone should not be weathered.

3.4 Steel Reinforcement

Type

Steel for bar and fabric reinforcement shall conform to mild steel of tested quality conforming to IS. 432 (Latest), or high yield strength deformed bar conforming to IS. 1786 or 1139 (Latest) as specified in the drawings. The steel shall be kept clean and free from pitting, loose rust, mill scale, oil, grease, earth, paint or any material which may impair the bond between the concrete and the reinforcement or which may cause corrosion of the reinforcement or deterioration of the concrete. Fabric reinforcement (IRC weld mesh or equivalent) shall be delivered to site in flat sheets only.

Extra provision For Super Ductile Corrosion Resistant Steel (CRS) high strength ribbed TMT bar of all size & FE 500D grade.

Storage of Reinforcement

Before and after bending, reinforcement shall be stored on raised racks in separate lots by size and type and protected from damage, contamination and the effects of the weather. For the purposes of identification each lot shall be marked plainly and securely by approved methods.

List of Steel Manufacturer in order of Merit

Reinforcement Steel: **SAIL/TISCO/Rashtriya Ispat Nigam Ltd. (RINL)**

Fabrication

Fabrication shall be accurately done to the dimensions, spacing and minimum cover as per structural drawings. Spacers shall be of cement mortar (1:2) cubes. MS chairs, spacer bars shall be used in order to ensure accurate positioning of reinforcement. All joints in mild steel reinforcement up to and including 16 mm dia, shall be overlapped. The length of over lap for tension and compression joints in mild steel reinforcement above 16 mm diameter may be welded if permitted by the Architect/Project Managers in writing.

Welded Laps

Wherever specified, welded laps shall be provided and paid for separately unless specifically included in the item of work. The welding of bars shall be carried out as per IS: 2751-1979, IS: 9417-1977. Before doing welding of bars at site, the contractor shall make minimum 3 joints and get them tested in an approved laboratory at his own cost. The following precautions shall be taken:

a) If the cold twisted deformed bar has an untwisted end at lapping point, then
b) this portion shall be cut off prior to welding.
c) Bars shall be free from rust at joints to be welded.
d) Bars shall be aligned and kept in proper axis in order to minimize crookedness in bar after welding.

3.5 Water

Type

Water for mixing concrete shall be clean and free from harmful material and comply with the requirements of Clause 4.3 of IS:456 (Latest Revision).

Water shall be brought only from sources approved by the Architect/Project Manager, and shall be used in a manner as directed by the Architect/Project Manager.

Testing of Water

Prior to the commencement of the works, or whenever there is a change in the source of supply or when directed by the Architect/Project Manager, the contractor shall arrange for samples of water, for mixing concrete, to be submitted to an independent Government authorized testing laboratory, acceptable to the Architect/Project Manager for tests to determine that the water complies with this specification and is satisfaction in all other respects for the manufacture of high quality concrete.

3.6 Grades and Strength Requirements of Concrete

General

Concrete shall consist of the material described under previous sections, using separate coarse and fine aggregate in an appropriate combination determined in the course of the preparation of mix design described hereinafter. The overall grading shall be such as to produce a concrete of the specified quality which will work readily in to position without segregation and without the use of excessive water. In the case of mass concrete or blinding concrete specified by nominal mix the use of "all-in" (20 mm and down) aggregate may be approved by the Architect/Project Manager. No addition of water shall be made at site. It shall be a homogenous mix before use at site.

Slump

Only sufficient 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 throughout the corresponding parts of the work and tests shall be conducted to ensure the maintenance of this consistency according to the standard method of test for consistencies of concrete (slump test) as below :

Description of work	**Maximum slump in mm.**
Beams and slabs	25 to 75 mm
Columns & Walls	50 to 100 mm
Slabs & Staircase	upto 25 mm
Footings	upto 25 mm

Concrete Grades

Grade of concrete used in the works shall be shown on the drawings or as directed by the Architect/Project Manager. For each grade of concrete the requirements are set out in the following Table :

a) Normal Concrete

By Volume Mix.	Min. cement Content Kg/Cum.**(*)**	Compressive strength (Kg/Sqcm) 7 Days	28 days
1:2:4	318 Kg.	140 Kg/Sq.cm.	210 Kg/Sq.cm.
1:1½ :3	405 Kg.	175 Kg/Sq.cm.	265 Kg/Sq.cm.
1:1:2	565 Kg.	210 Kg/Sq.cm.	315 Kg/Sq.cm.

b) Controlled Concrete

For controlled concrete by strength, the minimum stresses shall not be less than as specified below :-

Grade	Min. cement Content Kg/Cum.**(*)**	Compressive Strength Kg/Sq.cm 7 days	28 days
M - 10	170	70	100
M - 15	270	100	150
M - 20	300	135	200
M - 25	300	170	250
M - 30	320	200	300
M - 35	340	235	350
M - 40	360	270	400

(*) This is only minimum quantity to be used and the contractor should actually use the required quantity of cement without any extra cost. If the mix with minimum cement content gives higher strength, no extra will be paid to the contractor.

3.7 Batching and Mixing

The quantity of cement, the quantity of fine aggregate and the quantities of the various sizes of coarse aggregate should be measured by weight.

A separate weighing device should be provided for weighing the cement. Alternatively, the cement may be measured by using a whole number of bags in each batch, 50 Kg. bag of cement contains 35 Ltrs.

The amount of water should be measured by volume or by weight. Any solid admixtures to be added should be measured by weight. Liquid or paste admixtures may be measured by volume or weight.

The batch weights of aggregate should be adjusted to allow for moisture content typical of the aggregate being used.

The accuracy of the measuring equipment should be within plus or minus 3% of the quantity of cement, water or total aggregates being measured and within plus or minus 5% of the quantity of any admixture being used. All measuring equipment should be maintained in a clean, serviceable condition.

The mixing time should not be less than that used by the manufacturer in assessing the mixer performance. In the case of mixes of low workability or high cement content this may not ensure maximum strength, and it may be advisable to determine a satisfactory mixing time by comparing the strength of samples mixed for different times. However in no case shall it be less than 2 minutes.

A mixer shall be cleaned out before any further concrete is mixed:

a) When it has been out of use for more than 30 minutes, or
b) When the class of concrete to be mixed is changed.

Hand mixing will only be permitted in exceptional circumstances and then with the specific arrangement of the Architect/Project Manager.

No water shall be added to mixed concrete other than the quantity of water allowed for in the mix design and incorporated in batching, unless with the approval of the Architect/Project Manager.

Concrete or mortar which has commenced to set shall not be remixed with additional water and in no circumstances shall such concrete or mortar be used in the work.

3.8 Transporting Concrete

Concrete and mortar shall be transported speedily in water tight skips, trucks or barrows, and deposited in its place in the works without contamination, loss of ingredients or segregation. If segregation has nevertheless occurred during transport, the materials shall be remixed before deposit. Skips shall be large enough to contain an integral number of batches from the mixer. Any trucks or barrows shall have pneumatic tyres. In no case shall a period of more than 30 minutes elapse between the first wetting of cement in a batch and the completed use of the concrete or mortar in the works, the contractor shall arrange his mixing, transporting, placing, compacting and finishing techniques accordingly. No concrete shall be placed in the works until the contractors' proposed method of transporting concrete have been approved. When concrete is conveyed by chutes, the equipment shall be of such size and design as to ensure a continuous flow in the chute. The chute shall be of metal or metal lined, and if two or more lengths are used they all shall have approximately the same slope. If the distance of the discharge end of the chute above the surface of the concrete is more than 1 metre, a spout or "elephant trunk" shall be used and the lower end positioned as near to the surface of deposit as practicable. The chute or "elephant trunk" shall be thoroughly cleaned before and after each run. The debris and any water used shall be discharged outside the forms.

3.9 Concrete placement

General

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

The concrete shall be placed in the positions and sequences indicated on the drawings, in this specification and/or as directed by the Architect/Project Manager.

Contractor shall give adequate notice to the Architect/Project Manager 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/Project Manager 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/Project Manager. 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 segregations.

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.

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.

3.10 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/Project Manager. 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/Project Managers' 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 Maintenance of Plant and Equipment

The contractor shall keep all weight batching machines, mixing machines, compressors, vibrators and other plant and equipment for concrete and mortar work clean, well maintained and adjusted and where appropriate, shall check the accuracy of the measuring devices at regular intervals, all to the approval of the Architect/Project Managers' Representative. Mixer blades shall be replaced when worn down by 20 mm.

3.12 Night Work

Concrete shall not be mixed, placed, compacted or finished during the hours of darkness, except where necessary to complete a pour. However, concreting in darkness for these exceptions shall be only after obtaining the express permission in writing from the Architect/Project Managers' representative and in his presence only.

3.13 Compacting Concrete

The concrete shall be fully compacted throughout the full extent of the layer. It shall be thoroughly worked against the moulds, and around any reinforcement and other embedded items without displacing them, and in to corners of the moulds. Successive layers of the same lift shall be thoroughly worked together adjacent to the common face. The date of laying concrete shall be marked for curing and removal of form work.

Immersion vibrators shall be of approved type and shall have frequency of not less than 10000 oscillations per minute. They shall penetrate the full depth of the concrete to be vibrated and be immersed at sufficiency close spacing so that the whole volume of the concrete is satisfactorily and uniformly compacted.

Where the underlying layer is of fresh concrete, immersion vibrators shall also penetrate that layer to ensure homogeneity. Immersion vibrators shall be withdrawn slowly to prevent formation of voids. Vibrators shall not be used to work the concrete along the moulds or in such a way as to damage shuttering or other parts of the structure or to displace the reinforcement or other embedded items. Immersion vibrators shall only be operated by those who have received proper instruction and training in their use.

External vibrators shall be of approved type and shall have a frequency of not less than 3000 oscillations per minute. They shall be securely and rigidly clamped to the shuttering. External vibrators shall only be used on shuttering which is strong enough to withstand the vibration without displacement, distortion or other damage.

The contractor shall ensure that sufficient standby vibrators and ancillary equipment are available during concreting operations.

3.14 Quality Control

i) 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.

ii) As frequently as the Architect/Project Managers' representative may require and in any case at least once a day while concreting is in progress, the contractor shall sample and carry out a determination of the moisture content and a mechanical analysis of the fine aggregate and each nominal size of coarse aggregate shall lie within the respective limits specified and should be fraction of aggregate in the sieve differ from the corresponding fraction of aggregate in the approved mix by more than 2% of the total quantity of fine and coarse aggregate, the Architect/Project Manager may instruct the contractor to modify the relative proportions of the aggregates in the mix immediately to allow for such differences.

iii) 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.

iv) 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 meters of concrete placed in the works or twice per week.

v) Notwithstanding the foregoing, additional samples shall be taken by the contractor when directed by the Architect/Project Manager. The test cube procedure shall be in accordance with IS: 516 throughout.

vi) 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.

3.15 Seven day cube tests

Acceptance of concrete is based on the 28th day results. However, the contractor shall establish a relationship 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 relationship 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 advice the Architect/Project Manager 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.

3.16 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/Project Manager 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/Project Manager. At the discretion of the Architect/Project Manager, 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.

3.17 Construction joints

Construction joints shall be provided in the position described on the drawings or elsewhere and where not so described on the drawings or else shall be in accordance with the following :-

a) A joint shall be formed horizontally at the top of a foundation and 75 mm below the lowest soffit of the beams meeting at the head of a column.

b) A joint shall be formed in the rib of a large tee beam and all beams 25 mm below the soffit of the slab.

c) Concrete in a haunch or a splay on beam or a brace, and in the head of a column where one or more beams meet, shall be placed without a joint at the same time as that in the beam or beams or brace.

d) Concrete in the splay at the junction of a wall and slab shall be placed throughout without a joint, but if the provisions of a joint are unavoidable, the joint shall be vertical and the middle of a span.

e) A joint in a slab shall be vertical and parallel to the principal reinforcement, where it is unavoidable, at the right angles to the principal reinforcement, the joint shall be vertical and at the middle of the span.

f) Expansion joints, hinges or other permanent structural joints shall be provided in the positions and of the form described in the drawings or elsewhere. Before placing new concrete against concrete that has already hardened the face of old concrete shall be cleaned and roughened and scrubbed and loose aggregate removed from the form. Immediately before placing the new concrete the face shall be thoroughly wetted and a coating of neat cement grout applied thereto. The new concrete shall be well rammed against the prepared face before the grout sets.

3.18 Form Work

Form work construction

i) The contractor should submit detailed drawing of the centering & shuttering and get the same approved from the Architect/Project Manager/Client and before laying concrete also he should get the centering shuttering approved in writing before start of concreting. The concreting should be done in the scientific and methodical manner so as to give a uniform finish in line and level, so that minimum rendering or plastering is done. The work found defective, should be dismantled & redone and site cleared.

i) Form work shall be so constructed that concrete can be properly placed and thoroughly compacted. Form work shall be firmly supported and adequately strutted, braced or tied. It shall be capable of adjustment to the lines and dimensions of the finished concrete, and it shall be sufficiently strong to resist without excessive distortion under the influence of the weather.

iii) All form work shall be constructed to be rigid during the casting of concrete and constructed so that the surfaces adjacent to the concrete are with plus minus 6 mm or the required surfaces when supporting the concrete and sufficiently watertight to prevent loss of liquid from the concrete, and it shall be capable of being removed without shock or vibration to the concrete. Forms shall be cleaned with compressed air immediately before placing concrete to remove all rubbish. The inside faces of the form work shall be treated with a mould oil of type to be approved by the Architect/Project Manager ad every care shall be taken to prevent mould oil from getting on to the reinforcement.

iv) Shuttering shall be braced and strutted to prevent deformation under the weight and pressure of the wet concrete, constructional loads, wind and other forces. The deflection shall not exceed 3 mm bottoms of beams boxes shall be erected with an upward camber of 6 mm for each 3 M. of span.

Removal of Form work (Striking Time)

Unless certainly specified in the drawing, or directed by the Architect/Project Manager, the following shall be minimum intervals of time which should be allowed between the placing of the concrete and the striking of the mould where ordinary Portland cement is used.

	Type of formwork	**Minimum period before Striking Formwork**
a)	Vertical formwork to columns, walls, beams	16-24 hours
b)	Soffit formwork to slabs (Props to be re-fixed immediately after removal of formwork)	3 days
c)	Soffit formwork to beams (Props to be re-fixed immediately after removal of formwork)	7 days
d)	Props to slabs :	
	i) Spanning upto 4.50 m	7 days
	ii) Spanning over 4.50 m	14 days
e)	Props to beams and arches	
	i) Spanning upto 6 m	14 days
	ii) Spanning over 6 m	21 days

Note: 1. For other types of cement and lower temperature, the stripping time recommended above may be suitably modified

2. The number of props left under, their sizes and disposition shall be such as to be able to safely carry the full dead load of the slabs, beam or arch as the case may be together with any live load likely to occur during curing or further construction.

However, the Contractor shall delay the removal of shuttering as long as necessary in order to avoid damaging the work. Where shuttering to soffit is removed prior to the props this is only permissible if the design of the shuttering allows such a sequence of operations without the props being in any way disturbed. If the shuttering and props are not independent, both must be left in place until propping is no longer required.

Where shuttering to sides is removed prior to the shuttering soffit, the side shuttering shall be removed without disturbing the shuttering to the soffit.

No concrete structure shall be loaded until the concrete is at least **21 days** old and only then with the approval of the Architect/Project Manager and subject to such conditions as may be imposed.

The contractor may be required to produce evidence that the concrete has attained strength sufficient to support the live and dead loads to which that part of the structure may be subjected. This evidence shall consist of reports of compression tests made on job cured test cubes. The cost of such tests shall be borne by the contractor. The foregoing provisions of this clause shall not relieve the Contractor of his responsibility to ensure that the stability and strength of any structure or part of a structure is not impaired by the release of shuttering.

Proposals for form work

Not less than 8 days before the contractor proposes to construct any form work his detailed proposals thereof shall be delivered to the Architect/Project Manager. Proposals shall comprise all relevant information including calculations, detailed drawings, rates of placing of concrete, sequence of placing of concrete and details of any external vibrators which are proposed to be used.

No form work shall be constructed until the Contractors' proposals have been received and approved by the Architect/Project Manager.

Type of form work

Two quantities of form work shall be used i.e Rough form work and wrought form work, as noted on the Architect/Project Managers' drawings or described hereafter.

Rough form work may be constructed of sawn timber or other material as agreed by the Architect/Project Manager. The edges of the boards shall be planned or otherwise rendered grout tight. Provided it remain grout tight, rough form work may be used any number of time.

Wrought form work, to all surfaces for which a smooth fair faced finish is required, shall be constructed of purpose-made metal, fibre glass, water proof ply wood panel, hardboard lined form work or of planed timber with edges shot so that tight joints can be formed which will prevent loss of liquid from the concrete. The use of a particular material for wrought form work shall be consistently maintained throughout the structure. The surfaces of the form work in contact with the concrete shall be smooth and free from all blemishes. The number of times wrought form work may be used shall be subject to the surfaces, joints and edges being clean and undamaged.

Surfaces of concrete

The contractor shall ensure that the finished face of concrete offers a suitable keyed surface for the application of the finishing media, e.g. plaster, sand and cement screed, etc. The contractor shall also ensure that where thin films of finished, e.g. skim coats "Snowcem", paint, etc. are to be applied that the previous provisions regarding supporting of form work are complied with, so that the concrete faces to be treated are left smooth, unblemished and true to line both vertically and horizontally and require no making good before applying the finish.

Should the contractor fail however, to comply with the provision of this Clause, he shall submit details of his proposed method of redoing the situation to the Architect/Project Manager and must obtain written consent from the Architect/Project Manager to the proposals before continuing with any further work on the affected surfaces.

Tolerances in concrete surfaces

The permissible tolerance in the surface of the hardened concrete shall not exceed the following limits :

Type of irregularity	
Departure of member planes from position and level.	+ 12 mm
Variation in cross-sections	+ 6 mm
Sharp changes in plane	+ 2 mm
Departure from 3 M. template of any part of planes	+ 3 mm

3.19 Curing

Canvass, Hessian or other approved screens shall be erected at all points where concrete is being placed to shade the concrete from the direct sun or from drying winds and such screens shall be kept in position until the surface of the concrete has been protected as specified in the following Clauses. The contractor shall be responsible for removing such screens and preparing surface of concrete.

As soon as possible after it has been placed and concrete shall be covered with Hessian or other approved material to protect it from the sun and all concrete surfaces shall be kept visibly wet continuously for 14 days after placement, the Hessian being kept in position throughout this period. Surfaces cast against forms shall also be kept moist and covered with Hessian for these periods if the form work is removed before the periods have elapsed.

The top surface of slab shall be kept flooded with water at all times till the curing period of 14 days is over. Columns, wall and beam sides and other surface shall be completely covered by gunny bags and kept thoroughly wet continuously for the period specified for curing. The ceiling of slabs shall be frequently sprayed with water until the end of curing period.

The contractor shall ensure that all times there is an adequate supply of fresh water available for curing the concrete.

3.20 Examinations and Repairs

The contractor shall not proceed with the surface finish or making good of concrete surfaces until he has received the Architect/Project Managers' written permission to do so and he shall not apply cement slurry or mortar or any other coating to the concrete surfaces as struck from the shuttering or do anything else which would hinder the proper inspection of the concrete by the Architect/Project Manager.

Concrete which is defective, has honeycombs, or which contains defective parts shall be cut out completely unless the Architect/Project Manager agrees that a repair may be satisfactorily effected. This agreement shall not preclude subsequent condemnation of the repaired work.

The method of repairing defective concrete which the contractor proposes to adopt shall be submitted to the Architect/Project Manager for his prior written agreement in each particular case.

No repairs or remedial work shall be carried out without prior inspection and instructions of the Architect/Project Manager. (No extra shall be paid to the contractor for the repair works).

3.21 Fair face finish to concrete surfaces

Concrete surfaces shall be finished smooth fair faced where indicated as such on the drawings. These areas shall be entirely free from honey combing, stains, fins, lipping, nail or screw marks, raised grain marks, air holes or any other imperfections. They shall also be of even texture throughout. Very slight variations between member and member may be acceptable but any such variations within a single member cannot be tolerated. The concrete faces shall not be marked with mould oil.

The form work to these areas shall be wrought form work as specified herein.

Following inspection by the Architect/Project Manager the whole surface shall be rubbed down by hand. Any surfaces with major imperfections, i.e. greater than can be easily, completely and permanently obliterated by rubbing down shall be reported immediately to the Architect/Project Manager.

Remedial work is not normally possible to the above fair faced finish surfaces and the Contractor will be required to demolish and recast defective works.

3.22 Reinforcement Fabrication

Bar Bending Schedules

The Contractor shall submit to the Architect/Project Manager, for the Architect/Project Managers' approval, bar bending schedule for all the works, not less than Ten days before the contractor intends to bend the reinforcing steel.

The Approval of the Architect/Project Manager shall in no way absolve the contractor of his responsibilities under the Contractor.

Programme of reinforcement details required

The Contractor shall provide a programme which gives the Architect/Project Manager atleast 28 days prior notification of any reinforcement details required. The contractor shall justify the practicability of his programme to the Architect/Project Manager should it seem unreasonable before the programme be regarded as valid notification. If progress on site falls behind the contractors' programme, the issue of reinforcement details may be delayed by a period corresponding to the delay in construction.

Bending and placing reinforcement

Reinforcement shall be cut and bent to the shapes and dimensions shown on the finally agreed bending schedules in accordance with the requirements of IS: 2502 and to the tolerances set out therein.

Bending shall be carried out with an appliance which provides a continuous and uniform application of the bending deformation at every section of the bend. There shall be provision for the free movement of the surface of the bar during bending and the bends shall follow the contour of the former without peaking.

High Yield reinforcement must be bent without the application of artificial heating.

Mild steel reinforcement may be bent either hot or cold but shall not be heated to a temperature greater than 85^0C., and if heated not cooled by quenching.

Mild steel reinforcement temporary left projecting from the concrete at construction or other joints shall not be bent out of position unless shown on the drawings or agreed by the Architect/Project Manager. Where such bending and subsequent rebinding takes place the radius of the bend shall not be less than 4 bar diameters.

Reinforcement shall be fixed without forcing in the position shown on the drawings within a tolerance of 5 mm or 5% of the minimum dimension of cross section, whichever be the greater and maintained so that it is not displaced during concreting or other operations.

Horizontal bars shall be supported sufficiently to prevent displacement. This may be plastic spacers, chairs bent from steel bar, or by concrete blocks. The method and sufficiency of the support shall be subject to the approval of the Architect/Project Manager.

Where concrete blocks are used, they shall be precast from concrete (not mortar) of the same class as the concrete in which they are to be embedded, except that the largest size of aggregate shall be 10 mm. Each block shall be secured to the reinforcement with wire or a clip embedded in the centre of the block so that, it shall not be in contact with the shuttering or subsequently cause rust marks on the concrete. Intersections of reinforcement shall be bound together with 16 gauge annealed soft iron binding wire.

Unless otherwise noted on the drawings, no intersections of reinforcement may be fixed by welding without the permission of the Architect/Project Manager. High yield and cold worked steel shall, in no circumstances, be welded together.

Should any difficulty arise during the placing of steel in obtaining the appropriate cover, the contractor shall immediately draw the attention of the Architect/Project Manager to the difficulty and shall carryout such corrective measures as the Architect/Project Manager may suggest.

Protection of reinforcement and concrete

The Contractor shall ensure that movement of men and material subsequent to steel fixing is organized so that reinforcement is not thereby displaced.

Reinforcement left projecting from any concrete shall be protected so that there is no risk of corrosion staining to any exposed concrete surface or to any other part of the works. For this purpose a stiff grout wash will normally be acceptable to the Engineer, this wash shall be wire-brushed vigorously before further concrete is placed to remove any ill- bonded material.

3.23 Precast concrete units

Precast concrete materials and workmanship shall be in accordance with specifications unless indicated otherwise. Where different tolerances are indicated in this specification or on the drawings from these in the more severe tolerances shall apply. The units shall all be cast in properly made strong moulds to form the shapes required. For work described as "finished fair" the mould shall be lined with sheet steel or other approved material and care should be taken to ensure no damage is caused to edges or surfaces when units are removed from the moulds.

The concrete shall be of the mixes given on the drawings and shall be thoroughly vibrated in the moulds.

All precast work shall be cast under cover and shall so remain for seven days and shall be kept damp in order that the units are properly matured. No units shall be lifted until 18 days have elapsed since casting and no unit shall be erected until it has been approved by the Architect/Project Manager as free from defects.

No cracked units will be accepted for incorporation in the works.

All reinforced structural precast units shall have the tops clearly marked.

Unreinforced precast units, such as sills and copings, shall be lightly reinforced as necessary to facilitate handling.

3.24 Lime sand mortar pad

Where specified lime mortar padding shall be provided. Lime for padding shall be in the form of a fine dry powder produced by treating quick lime in any suitable form with sufficient water so as to produce a completely hydrated but dry and sound product. It shall be brought from approved manufacturers and it shall be used within 3 months of its date of manufacture. It shall be supplied in suitable containers such as jute bags lined with polythene or high density polythene woven bags. The hydrated lime shall bear the type of lime, brand, make of approved manufacturer, net weight and date of manufacture.

Sand: As described in cement concrete.

Proportioning: The ingredients in specified proportions shall be measured using boxes of suitable sizes. Sand shall be measured on the basis of their dry volume.

Mixing: The mixing of ingredients of mortar shall be done in a mechanical mixer. However, project engineer can relax this condition at his discretion, taking into account the nature, magnitude and location of the work, practicality of the use of these machines etc. The ingredients of the mortar shall be fed into mechanical mixer

mix dry before adding water. After dry mixing is complete, just sufficient, quantity of mortar shall be added to bring it to a working consistency. The mortar shall be mixed at least for three minutes after the addition of water.

If the mortar is to be used for padding below foundations or floor very litter water shall be added to dry mortar to make stiff consistency and shall be laid in 100 mm thick layers thoroughly compacted. During compaction small quantity of water shall be sprinkled according to requirements.

Precautions: Lime mortar shall be used as soon as possible after mixing or grinding. As a rule mortar shall be used on the day it is made. If eminently hydraulic lime (Class-A) is present as an ingredient, the mortar shall be used within four hours after mixing or grinding in mortar mill or mixture. Lime mortar made with semi-hydraulic lime (Class-B) or fat lime (Class-C) and Pozzolana as ingredients shall be used within 36 hours of mixing of grinding and lime sand mortar within 72 hours. After the close of each day's work, mixing trough pans shall be thoroughly washed and cleaned. Lime mortar shall be keep damp with wet sack or by any other suitable means and shall on no account be allowed to dry.

3.25 Ready mix concrete

Grades and Strength Requirements of Concrete

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 a 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.

RMC (Ready Mix Concrete) Plant

Alternatively, the contractor may be allowed by Engineer-in-Charge to arrange Ready Mix Concrete (RMC) from producing plants. The RMC plant proposed to be engaged by the contractor shall fulfill the following requirements:

a) It shall be fully automatic and computerized with facility for providing printed advice showing ingredients of concrete carried by each mixer.

b) It should have supplied RMC for projects of similar magnitude.

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

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

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

f) Use of Fly ash/ mineral based admixtures in RMC shall not be permitted without prior approval of Engineer-in-Charge.

g) No addition of water or other ingredients shall be permitted in the RMC at site or during transit.

h) Concrete shall be placed by pump of suitable capacity or tower crane or boom placer and the contractor shall arrange sufficient length of pipe at site to place the concrete in the minimum required time. Nothing extra shall be paid for placing of concrete through concrete pump/ tower crane/boom placer.

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 throughout 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.

Mixing

All cement concrete plain or reinforced shall be machine mixed. Mixing by hand may be employed where quantity of concrete involved is small, with the specific prior permission of the **Engineer-in-Charge**. 10% extra cement shall be added in case of hand mixing as stipulated in IS-456.

For large and medium project sites the concrete shall be sourced from ready- mixed concrete plants or from on site or off site batching and mixing plants (IS 4926)

Water Cement Ratio, Laying & Curing

Water Cement Ratio, Laying & Curing shall be done as per IS: 456.

Grades of Concrete

Grades lower than M 25 shall not be used in reinforced concrete.

A sieve analysis test of aggregates shall be carried out as and when the source of supply is changed without extra charge notwithstanding the mandatory test required to be carried out as per CPWD specification.

All tests in support of mix design shall be maintained as a part of records of the contract. Test cubes for mix design shall be prepared by CONTRACTOR under his own arrangements and at his costs, but under the supervision of the **Engineer-in- Charge**.

Design Mix Concrete

Design mix shall be allowed for major works where it is contemplated to be used by installing weigh batch mixing plant as per IS 4925. At the time of tendering, CONTRACTOR, after taking into account the type of aggregates, plant and method of laying he intends to use, shall allow in his tender for the design mix i.e., aggregate/cement and water/cement ratios which he considers will achieve the *strength requirements specified, and workability for concrete to be properly finished.*

Before commencement of concreting, **CONTRACTOR** shall carry out preliminary tests for design mix on trial mixes proposed by him in design of mix to satisfy **Engineer-in-Charge** that the characteristic strength is obtained. In this regard, CONTRACTOR may consult govt. approved/reputed institute to get design mix done as per IS 10262 at his own cost. The concrete mix to be actually used shall be approved by the **Engineer-in-Charge**.

Notwithstanding the above, the following shall be the maximum combined weight of coarse and fine aggregate per 50 kg of cement.

Grade of Concrete	**Maximum weight of fine & coarse aggregates together per 50 kg of cement (for nominal mix only)**
M-10	480 Kg
M-15	350 Kg
M-20	250 Kg

The workability of concrete produced shall be adequate, so that the concrete can be properly placed and compacted. The slump shall be as per IS 456.

The minimum consumption of the cement irrespective of design mix shall not be less than the following:

M 7.5	170 Kg / m^3
M 10	220 Kg / m^3
M 15	250 Kg / m^3
M 20	300 Kg / m^3
M 25	300 Kg / m^3

Testing of Concrete

Testing of concrete, sampling and acceptance criteria shall be in accordance with IS

Proportioning

Mixes of cement concrete shall be as ordered. Where the concrete is specified by grade, it shall be prepared by mixing cement, sand and coarse aggregate by weight as per mix design. In case the concrete is specified as volumetric mix, then dry volume batching shall be done, making proper allowances for dampness in aggregates and bulking in sand. Equivalent volume batching for concrete specified by grade may however be allowed by the **Engineer-in-Charge** at his discretion.

Pre Cast Concrete

The specifications for pre cast concrete will be similar as for the cast in situ concrete. All pre cast work shall be carried out in a yard made for the purpose. This yard shall be dry, properly levelled and having a hard and even surface. If the ground is to be used as a soft former of the units, shall be paved with concrete or masonry and provided with a layer of plaster (1:2 proportion) with smooth neat cement finish or a layer of MS sheeting. The casting shall be over suitable vibrating tables or by using form vibrators as per directions of **Engineer-in-Charge**.

The yard, lifting equipment, curing tank, finished material storage space etc. shall be designed such that the units are not lifted from the mould before 7 (seven) days of curing and can be removed for erection after 28 (Twenty Eight) days of curing. The moulds shall preferably be of steel or of timber lined with G.I .sheet metal. The yard shall preferably be fenced.

Lifting hooks, wherever necessary or as directed by **Engineer-in-Charge** shall be embedded in correct position of the units to facilitate erection, even though they may not be shown on the drgs. and shall be burnt off and finished after erection. Pre cast concrete units, when ready shall be transported to site by suitable means approved by **Engineer-in-Charge**. Care shall be taken to ensure that no damage occurs during transportation. All adjustments, levelling and plumbing shall be done as per the instructions of the **Engineer-in-Charge**. CONTRACTOR shall render all help with instruments, materials and staff to the **Engineer-in-Charge** for checking the proper erection of the pre cast units.

After erection and alignment the joints shall be filled with grout or concrete as directed by **Engineer-in-Charge**. If shuttering has to be used for supporting the pre cast unit they shall not be removed until the joints has attained sufficient strength and in no case before 14 (fourteen) days. The joint between pre cast roof planks shall be pointed with 1:2 (1 cement : 2 sand) mortar.

STEEL REINFORCEMENT

High yield strength deformed TMT steel bars of grade Fe500D conforming to IS:1786 shall be used.

All joints in reinforcement shall be lapped adequately to develop the full strength of the reinforcement as per provision of IS: 456 or as per instruction of **Engineer-in-Charge**.

Form Work

The shuttering or form work shall conform to the shape, lines and dimensions as shown on the drawings and be so constructed as to remain sufficiently rigid during placing and compacting of the concrete and shall be sufficiently tight to prevent loss of liquid from the concrete. The surface that becomes exposed on the removal of forms shall be examined by **Engineer-in-Charge** or his authorized representative

4.0 MASONRY WORKS

4.1 Brick Works

i) The bricks shall conform to the IS No. 1077-1986 of minimum crushing strength of 75 Kg./Cm_2.

ii) The building bricks are to be the best quality table moulded kiln burnt, patent bricks, hard sound, square with sharp arises, even and uniform in shape and colour free from cracks, stones, flaws and other defects. Samples of bricks are to be submitted to the Architect/Project Manager for approval before full quantity is ordered. All supply of brick to conform to the sample approved. No brick after 24 hours immersion in water shall absorb water more than 15% of its own weight.

iii) The cement and sand shall be as described under 'Cement Concrete' and the mortar unless specified otherwise in BOQ is to be composed of one part cement to four parts of coarse sand by volume, thoroughly mixed by hand. Hydrophobic cement used in mortar shall be thoroughly machine mixed. No mortar that has started to set shall be used in the work.

iii) Every brick shall be thoroughly soaked in water before use. Broken bricks shall not be used except as closers. The courses shall be truly horizontal and the work strictly plumb, joints shall be broken vertically and they shall not exceed 1/2" in thickness. All joints in brick work are to be well filled with mortar.

iv) The brick work shall not be raised more than 12 single courses per day and shall be built in English bond, except brick on edge and half brick thick walls shall be built in stretcher bond. Except for brick on edge work, the bricks shall be placed with "frog" facing upwards.

v) All joints in brick work shall be raked out 1/2" deep as the work proceeds, and before the mortar sets.

vi) The brick work is to be carried out with all necessary setbacks, projections, cuttings and toothings in conformity with the drawings.

vii) The brick work shall be cured by watering and continuously kept wet for 10 days, and the work shall be well protected during rainy season.

viii) All uneven, irregular and bad brick work poor in workmanship shall be demolished if deemed necessary by the Architect/Project Manager and rebuilt by the contractor at the contractors' expenses. If necessary the contractor will have to provide wooden plug, etc. for his own work and for which there will be no special payment on that account. The work will have to be executed at any height and lift will not form the criterion for any extra amount.

ix) Should any efflorescence be observed in brick work, it should be washed down by clean water and brick surface treated with such chemicals as are deemed necessary by the Architect/Project Manager without any extra charge and at the contractors' own expenses, till efflorescence subsides. Should the efflorescence persist, the brick work shall be demolished if deemed necessary by the Architect/Project Manager and the work rebuilt with new bricks including making good all the work disturbed without any extra charge.

x) This specification covers the construction of brick masonry in foundations, arches, walls, etc. at all elevations. The provision of IS: 2212 shall be complied with unless permitted otherwise.

xi) All bricks shall be of best locally available make and approved by Arcitect/Engineer-in-Charge. Minimum compressive strength shall be 75 Kg/cm^2.

4.2 Half brick masonry

All brick work under 115 mm thick shall be reinforced with hoop iron, 16 gauge 25 mm wide, or 2 Nos. 6 mm dia bars, in every coarse in the bottom for the first four coarses and in every fourth coarse thereafter. The said bars shall be cast in or securely fixed to adjoining concrete walls or columns. 75mm thick RCC band with 1:2:4 mix concrete and 2 Nos. 10 mm dia MS bars with 'U' shaped 6 mm dia MS strips @ 150 mm centres, shall be provided at every 2 metre height or as directed. RCC will be measured and paid for separately but its area will be deducted from brick work. No extra for the cost of hoop iron will be paid.

4.3.1 Autoclaved Aerated Concrete (AAC) block masonry conforming to I.S. 2185(Part- III):

6041 – 1985, I.S -1905 (latest edition).

SPECIFICATION SHEET

Product Dimension:

Product	Length	Height	Thickness
AAC Block	625 mm	250 mm	100 mm, 125MM,150 mm ,200 mm,225MM,300MM

Properties of AAC Block:

Properties	Values
Density (Oven Dry)	51-650 Kg/Cum
Compressive Strength	Minimum 30 Kg/cm2
Thermal Conductivity (K Value)	0.24 W/mK
Resistant to Fire	2 - 6 hrs depending upon Thickness
Drying Shrinkage	0.1 %
Design Gross Density	850 Kg/Cum. (appx.)

4.4 Mortar

The mortar for masonry work shall be cement and sharp coarse sand and shall be made in small quantities so as to be used up within 30 minutes. The cement and sand of the required proportion shall be first mixed dry thoroughly and water added and mixed to a sufficiently thick consistency as required by the Architect/Project Manager. No left over mortar shall be used. Unless otherwise specified the mortar shall be of the following proportions.

a) One cement and five coarse sand for 230 mm thick masonry work and above.

b) One cement and four coarse sand for piers, half brick walls, honeycombed brick work, hollow blocks.

c) Cement and water shall conform to the requirements laid down for cement concrete work.

d) Sand for masonry mortar shall be coarse sand conforming to IS: 2116. Maximum quantities of clay, fine dust shall not be more than 5% by weight. Organic impurities shall not exceed the limits laid down in IS: 2116.

e) Mix of mortar for building brick work shall be as specified in the item of work.

f) Mixing of mortar shall be done in a mechanical mixer. When quantity involved is small, hand mixing may be permitted by the **Engineer-in-Charge**. Any mortar remaining unused for more than 30 minutes after mixing shall be rejected.

4.5 Walls under structural members

Allowance shall be made for leaving, temporarily, open courses immediately below all structural members built in to the walls. The open courses shall be left to permit full deflection of structural members. The open courses shall then be made good, and pointed up after the structural members have been fully loaded and before the completion of the works.

5.0 CARPENTER AND JOINERY

5.1 Timber

All timber/ laminated veneer lumber conforming to IS: 14616 and TAD -15: 2001(Part B) shall be of the kind and of first class quality as described and indicated on drawings and schedules. It shall be uniform in texture, free from large, loose head or cluster knots, veneer, injurious open shakes, bore holes, rot, decay discoloration, soft or spongy spots, hollow pockets, pit and all other defects and blemishes. The sizes shown or described are to be taken as net sizes when finished.

5.2 Seasoning

All timber shall be fully seasoned, if necessary, in kilns, and the contractor shall produce satisfactory proof of the same.

The moisture content in the Timber, shall not exceed 12% for internal work and 16% for external work. The timber shall remain stable, free from expansion or contraction or any other movements, when fixed in position. The timber shall be free from drying defects and shrinkage.

5.3 Rough carpentry

Material

All framing and other concealed wood members shall be of sound wood or approved specials and shall be seasoned. All surfaces in contact with masonry or concrete, and in general, all surfaces hidden from view, shall be treated with two coats of approved wood preservative paint.

Workmanship

All carpenters' work shall be done by skilled workmen, with the longest nails that may be used without splitting the wood. In general top nailing and cross nailing shall be used. Wherever it is necessary, or an, adequate joint can not be formed by nailing, the members shall be lapped or jointed by GI straps or extra wood blocks. All jointing and nailing shall be done with neatness, especially in exposed positions. Joints and nailing shall be approved by the Architect/Project Manager and done according to his direction when required. Cross bracing, solid blocking and bracing shall be provided according to best practice.

5.4 Joinery

Materials

Finished wood work and joinery including doors, shall be with straight grained Indian Teak of approved quality, unless noted otherwise. Wood shall be free from knots, and other blemishes and imperfections. All finished wood for joinery shall be seasoned as prescribed before. All joinery work shall be securely mortised and tanoned and glued with best quality synthetic waterproof glue equivalent of FEVICOL or MOVICOL. All sections and dimensions shall be as shown on drawings. For all joinery work, nails shall not be permitted, and only wood screws of appropriate sizes shall be used. Wherever practicable, means of fastening the various parts together shall be concealed.

Installation

Doors, and cabinet work shall be installed in position only after the plaster in the section for which it is intended, is sufficiently dry.

All interior and exterior doors, cabinet work and other fixed wooden equipment shall be fixed plumb and true. Wherever possible, the joints shall be bevelled. All exterior angles shall be mitred. Adjoining interior wood members shall match and harmonize. All wood work in contact with masonry shall be painted with approved bitumen paint before placing in position. All concealed wood members shall be treated with anti-termite coating before placing in position.

Disclorin 18% LC	:	2 Litres
Pantachlophenel 12%	:	5 Litres
Kerosene Oil	:	93 Litres

5.5 Measurements

The Contractor shall be fully responsible for accuracy of all measurements and shall verify all dimensions given on the drawings, and shall make such site measurements as are necessary to complete the work properly.

5.6 Doors and Windows

Doors and windows and ventilator frames shall be made of laminated veneer lumber conforming to IS: 14616 and TAD -15: 2001(Part B) in factory made doors and window frames, and as shown on the drawing or as directed by the Architect/Project Manager/Client. These shall be properly framed mortised together, and set solidly in the masonry with MS holdfasts. Holdfasts will be 30 x 4 cms and 5 mm flat fixed to the jamb and embedded in masonry with PCC 1:2:4. Windows 1 mtr. high will have minimum of 6 number holdfasts. Each holdfast will be fixed to the frame with 3 Nos. of 5 cm. long galvanized iron screws. In case the frames are to be fixed to RCC members, suitable rawl plugs shall be used as directed by the Architect/Project Manager.

5.7 Flush Doors

All flush door shall be solid core as specified. It shall conform to the relevant specifications to IS: 2202 and shall be obtained from ISI approved manufacturers. The finished thickness of the shutter shall be as mentioned in the items. Face veneers shall be of the pattern and colour approved by the Architect/Project Managers and an approved sample shall be deposited with the Architect/Project Managers for reference. The solid core shall be wood laminates prepared from battens of well seasoned and treated good quality wood having straight grains.

5.8 Plywood

Plywood shall be best quality closed grained suitable for veneering, painting or bonded with plastic laminate. It shall be resin bonded and of waterproof and boil proof (WBP) brand. Exposed edges shall be finished with an edge strip of solid teakwood.

5.9 Chipboard

Wood chipboard shall be solid core flush door made from wood with a synthetic resin (Phenol Formaldehyde). Chipboards shall not be used externally or in damp surroundings. Only approved brand by the Architect/Project Manager shall be used in the works.

5.10 Glass and Glazing

The contractor shall furnish all labour, material and equipment required to complete the installation of all glass and related items. A glass shall be of the type, quality, and substance specified in the schedule of quantities. The contractor shall cut glass sizes by field measurements or dimensions of the approved shop drawings. The responsibility for correct glass sizes shall rest with the contractor. No cracked, chipped or disfigured glass shall accepted, and the contractor shall replace all breakages or faulty installation without cost to the Employer.

The glass shall be set in wood or metal glazing straps and metal sash with elastic glazing and compound. The glass shall be beaded first and so installed as to achieve a completely watertight result. The opaque glass, where called for, shall be set with the smooth surface outside. At the completion of the work all glass shall be thoroughly cleaned of paint and other marks removed. Any cracked, scratched, chipped or otherwise defective glass shall be removed and replaced without extra cost to the Architect/Project Manager.

5.11 Hardware

The contractor shall procure all the hardware as specified in the schedule. The rate shall include for making chases to receive the hardware, and also the cost of approved screws, nails, clamps etc. The fixing shall be done in the best workmanship like manner and in accordance with that employed for fixing hardware. Any damage to the joinery or the hardware shall be made good at no extra cost to the Employer.

5.12 Partitions/False Ceiling

Timber framing for partitions and ceiling shall be fixed by approved MS clamps, bolts or other equal and approved slotted angle suspenders and shall be treated with wood preservative using solignum or other equal and approved. Steel work within false ceiling shall be painted with two coats of priming Red lead paint. MS clamps, suspenders shall be welded to the MS hold down plates where provided in the structural soffit, or fixed in to the RCC work by cutting holes in approved manner and grouted with stiff mix of (1:1½:3) cement concrete.

6.0 METAL WORKS

6.1 Metal Casements

Frames of casements shall be of hot rolled sections. Both fixed and openable frames shall be constructed of sections which have been cut to length, mitred and electrically flush but welded at corners. Subdividing bar units shall be tennoned and riveted in to the frames. All frames shall have the corners welded to a true right angle and welds shall be neatly ground down smooth. Couplings, mullions, transom, and weather bar shall be provided, as directed by the Architects. Outer frames shall be provided with fixing screws and lugs shall be used for fixing the frame to the masonry. Mastic cements shall be used for making the joints watertight.

Hinges shall be of the strong projecting type. If directed, friction type hinges shall be used in which case windows shall not be fitted with peg stays. Projecting type hinged shutter shall be fitted with bronze, or brass peg stays, 30 cms long with pegs and brackets welded/riveted to the frame. All windows shall be provided with handles of brass or bronze, fixed with a square head bolt, which can be tightened if required after the glazing has been fitted. Top hung ventilators shall be fixed with plain hinges, riveted or welded to the fixed frame. A brass or bronze peg stays 30 cms. long as in windows, shall be provided.

Centre hung ventilators shall be hung on two pairs of brass or lead-tin-bronze cup pivots, riveted to the inner and outer frames of the ventilators, to permit the ventilators to swing through an angle of approximately 85^0. The opening position of the ventilator shall be so balanced to keep it open at any desired angle under normal weather conditions. A bronze spring shall be fitted in the centre of the top bar of the ventilator for the operation of the ventilator. This spring catch which shall be closed in to a mild steel iron catch plate, riveted or welded to outside of the outer ventilator bar. A brass chord pulley wheel in mild steel or malleable iron brackets shall be provided along with the chord pulley wheel in mild steel or malleable iron brackets shall be provided along with the chord eye.

The windows and ventilators shall be painted with approved paint. All the steel surface shall be thoroughly cleaned free of rust, scale or dirt and mill scale by picking or phosphating and before erecting painted with the coat of approved primer and after erection painted with two finishing coats of synthetic enamel paint of approved shade and quality. Glazing of special thickness shall be provided on the outside of frames and unless otherwise specified, metal beading of approved shape and section shall be used for fixing glasses. Special metal sash putty of approved make shall be used as directed.

6.2 Aluminium Doors, Windows, etc. Shop Drawings

Contractor shall submit to the Architect/Project Manager for their approval, shop drawings within 15 days of confirming the opening sizes. The drawings must indicate construction details, materials, fixing clamps etc. The contractor shall however make his own measurements to ascertain the actual openings on site and they will be responsible for the correctness of the sizes of the windows, louvers etc.

Protection against Wind and Weather

Contractor shall ensure that the members of the doors/windows/walling, shall withstand 150 Kg/Sqm. wind pressure, without deformation. The openable windows must not warp in the extreme climatic conditions. All calculations for the sizing of the members, must be lodged with the Architect/Project Managers. The contractor is however, responsible to replace any damaged member at their cost, if the same is found to be inadequate for extreme weather. The contractor must guarantee that the windows are completely waterproof.

The contractor shall submit one sample of each item for inspection and scrutiny and get the same approved by the Architect/Project Manager, prior to fabricating the remaining items.

All extruded aluminium sections shall be obtained from approved and established manufacturers and shall be of aluminium alloy conforming to IS:733. The sections shall generally conform to IS:1948. These shall be fabricated as per the approved shop drawings. All doors, windows and walling will be supplied complete with screws, beads, weather stripping and matching finish hardware.

All frames shall have corners fixed to a true right angles. For side hung shutters, hinges shall normally be of projecting type made of aluminium alloy and rivetted/welded to frames and shall have stainless steel pins. Handles, peg stays, etc. shall be of approved aluminium quality or its alloy conforming to ISspecifications.

The colour of anodizing shall be natural unless otherwise stated, and its sample shall be submitted for the Architect/Project Managers' approval before work commences. The sections shall be anodized to a minimum thickness of 15 microns/or as specified in the item of BOQ . The supplier must submit necessary evidence to the satisfaction of the Architect/Project Manager that the thickness of the anodization is not less than 15 microns/or as specified in the item of BOQ. In case of doubt the Architect/Project Manager reserves the right to send sample pieces to independent testing laboratories, at the cost of the supplier. If the testing laboratory report states that the thickness or quality of the anodization is deficient, the Employer may ask the contractor to treat the order as cancelled and the supplier in such a case shall indemnify the Employer of any loss incurred by the Supplier.

A frame should be made to fit the actual openings with a 5 mm clearance all round. Discrepancies in overall width or height exceeding 5 mm will not be allowed and the frames will be rejected in such cases. Small discrepancies shall have the gaps suitably filled with tropical grade mastic.

All ironmongery to be fixed to the frames shall be approved by the Architect/Project Manager prior to fixing. Glazing sections shall be lined with PVC gaskets to make the window completely waterproof.

The contractor shall provide all scaffolding ladders etc. for fixing the windows and glazing and no extra will be payable on this account.

6.3 Rolling Shutters

Rolling shutters shall be in extruded galvanized sections, of approved make, type and finish. These shutters shall be complete with locking arrangements, hoods, guides,

pulling devices, springs and other accessories. Wherever specified, mechanical device shall be fixed for easy operation of the shutters.

6.4 M.S Railing/Stainless steel railing

Brass balustrades shall be solid or hollow cold drawn bard and strips. All the parts shall be cold bent to exact shape and pattern shown in the drawing. The work shall be carried out by a specialized Agency, approved by the Architect/Project Manager. All ornamental castings shall be free from defects and shall match with the rest of the work.

All M. steel shall be Epoxy painted before handing over and given protective coats of Epoxy according to the manufacturers' instruction. All balustrades shall be set in lead and shall be plumb and rigid.

6.5 Stainless steel railing shall conform to sections in the drawing. Joints shall be neatly welded and grinded and polished. Balustrades shall be rigidly fixed by means of suitable ms sleeves or expanded fasteners.

6.6 Metal Fire rated Doors

Rating criteria should be specified in the item such as 1 hour rating , two hour rating. Generally it is 2 hour rating and should be as per BS: 476 part 22 and IS: 3614 part II.

Frame : shall be fabricated from 1.6 mm thick galvanized steel or 2 mm thick M.S.CRCA sheets depending on the size of the door. Frame will have single or double rebate profile. They will be provided with stiffeners for hardware /lock mounting and hold fasts grouting.

Shutter : Overall thickness of shutter shall be 43 mm formed from two outer skin panels of 1.25 mm thick galvanized steel sheets. Shutters should be of multi **–** bend construction with lock seam joinery for high strength and resistance. Reinforcement shall be provided in the shutter at locking / hardware area. The infill material shall be mineral wool.

Material : The sheet metal used for 1.6 mm thick frame and 1.25 mm thick shutter panels shall conform to IS: 277- 1992. The MS CRCA sheet conforms to IS: 513-1994. The doors shall be provided with **4"** long SS Magnum make hinges. The number hinges depend upon size of the door but in no case less than four hinges for each shutter.

7.0 FLOORING/DADO/CLADDING

7.1 General

All flooring shall be laid to the best practice known to the trade. The flooring shall be laid to the level except where slopes are called for on the drawings in which case the slopes shall be uniform and so arranged to drain in to the indicated outlets.

Particular care shall be exercised to ensure that all flooring, skirting and dado are perfectly matched for colour and finish. Sufficient extra tiles (not less than 5%) shall be cast/ordered to ensure an adequate supply of matched floor tiles. The contractor shall furnish for approval by the Architect/Project Managers, samples of each type of floor finish.

7.2 Cement Concrete flooring (IPS Flooring)

Indian patent stone flooring shall be 1.5" or of thickness specified and laid in two layers, bottom layer 1.1/4" thick or as specified in 1 part of Portland cement, 2 parts of coarse sand and 4 parts of crushed stone aggregate 1/2" down well graded machine mixed with not more than 5.5 gallons of water for each bag of cement and top layer 1/4" thick in one part of Portland cement, 2.5 parts of selected crushed stone chips 1/8" down with just enough sand maximum part to make workable mix, machine

mixed with not more than 5 gallons of water. Top layer to be laid before the bottom layer has hardened. Flooring shall be laid in squares or bays as directed and each layers shall be well compacted by ramming with heavy teak wood floats. The top shall be brought to a smooth and even surface free from blemishes and finished smooth by steel trowelling. After the concrete surface has hardened sufficiently to prevent dislodgement of aggregates, the patent stone shall be polished with No. 1, 2 & 3 polishing stone. The flooring shall be kept wet for seven days for curing.

Where ironite/hardonite topping is specified in the "Schedule of Quantities" the bottom layer shall be 40mm thick or in the item of B.O.Q. and the top layer shall be 12mm thick mixed with ironite/hardonite as per manufacturers specification and finished fair.

7.3 Ceramic/Glazed Tiles

All white or coloured glazed tiles shall be minimum 5 mm thick of approved manufacturer as stated in the schedule of quantities. Only first quality tiles of pure white/uniform colour and glaze shall be used. No cracked or warped tiles shall be used in the work. All tiles shall be required to be set in cement mortar. Prior to setting the tiles the contractor shall at his own cost, clear the whole surface and thoroughly saturate it with water. A layer of 12 mm thick cement mortar shall then be applied to the surface and the tiles laid firmly over a layer of clear cement slurry. The tiles shall be set in perfect line, level and true to plumb line. The joints of tiles shall have white or coloured cement painting. After the setting operation is completed, the contractor shall carefully remove all cement and dribbling and cure the tiled surface for atleast seven days with water.

7.4 Ceramic/Glazed tile dado

Glazed tile dado where called for in the drawings, shall be minimum 5 mm thick white glazed tiles of approved manufacture. The tiles shall be free from cracks, twists, uneven edges, cracking and such other defects. The rear face of tiles shall be grooved and/or recessed to provide an adequately key for the plaster. The tiles shall be laid true and plumb over a cement screed 12 mm thick composed of cement and sand 1:3 (1 cement: 3 coarse sand). The tiles shall be finally set in the mortar bedding, the joints in white cement slurry. After laying the tiles shall be thoroughly washed and cleaned to the satisfaction of the Architect/Project Manager.

7.5 Vitrified Tiles

All white or coloured glazed tiles shall be minimum 9.5 mm thick 600X600 and 10 mm thick 800X800 of approved manufacturer as stated in the schedule of quantities. Only first quality tiles of pure white/uniform colour and glaze shall be used. No cracked or warped tiles shall be used in the work. All tiles shall be required to be set in cement mortar. Prior to setting the tiles the contractor shall at his own cost, clear the whole surface and thoroughly saturate it with water. A layer of 20 mm thick cement mortar shall then be applied to the surface and the tiles laid firmly over a layer of clear cement slurry. The tiles shall be set in perfect line, level and true to plumb line. The joints of tiles shall have white or coloured cement painting. After the setting operation is completed, the contractor shall carefully remove all cement and dribbling and cure the tiled surface for atleast seven days with water.

7.6 Vitrified tile dado

Glazed tile dado where called for in the drawings, shall be minimum 9.5 mm thick 600X600 and 10 mm thick 800X800 tiles of approved manufacture. The tiles shall be free from cracks, twists, uneven edges, cracking and such other defects. The rear face of tiles shall be grooved and/or recessed to provide an adequately key for the plaster. The tiles shall be laid true and plumb over a cement screed 12 mm thick composed of cement and sand 1:3 (1 cement: 3 coarse sand). The tiles shall be finally set in the mortar 6 mm thickness, including grouting of joints in white cement slurry. After laying the tiles shall be thoroughly washed and cleaned to the satisfaction of the Architect/Project Manager.

7.7 Kota Stone Flooring

The best quality stone from approved quarry, shall be laid either with rough stone or machine cut and machine polished as specified in respective items and shall be of specified thickness and of approved quality and size, free from cracks and flakes and shall be uniform in colour, with straight edges. The sides of machine cut and machine polished stones shall have perfect right and finished as described under plain cement or colour, cement, tiles, on a beeding of 1:4 mix 20 mm (average) thickness. The finished stone surface thus laid shall then be polished to the required degree as approved by the Architect/Project Manager. Flooring shall be finally wax polished and protected till the handing over of the building.

7.8 Granite and Marble Stone

A) **Granite** : Granite shall be any colour and size as approved by the Architect. Granite shall be plain machine cut and mirror polished . The stone shall be smooth , of even surface without holes or pits. The stones shall be freeof warpage /curvature.

Physical properties :

1	Moisture absorption after 24 hrs immersion in water	Max 0.50 % by weight	IS 1124
2	Specific Gravity	Min. 2.6	IS 1122

Approval of sample : Before starting the work , the contractor shall get samples of Granite approved by the Architect. Approved samples shall be kept in the custody of the Architect and Granite supplied and used on the work shall conform to samples with regard to soundness, colour , veining and general texture.

Laying : All the stones shall be wetted before laying in position. These shall then be floated on mortar and bedded properly in position with wooden mallets without the use of chips or under pinning of any sort.

The walls and pillars shall be carried up truly in plumb or battered as shown in the drawings . All courses shall be laid truly horizontal and all vertical joints shall be truly vertical. The joints shall be finished smooth with matching filler.

Green work shall be suitably protected from damage during construction.

B) **Marble work :** Marble shall be the best Indian Marble to be approved by the Architect/Project Manager/Client and a sample piece should be kept in the office of the Project Manager. The quality shall be uniform and it shall be hard and free from any discolorations, cracks, flaws, veins of foreign materials or any other defects. When marble of different colour and kinds associated, care shall be taken to see that they are of equal hardness so as to wear evenly. The marble slabs shall be machine cut true to the shape and size and machine polished. Care shall be taken to cut the slabs so as to provide a pattern as indicated. Marble stone slabs for wall lining and dadoes shall be machine polished edges. The wall shall be lined with the marble in courses as indicated and grain of the marble shall be arranged in pattern as per detailed drawings.

The marble shall be bedded in cement mortar backing covering the full area of the marble. The wall surface shall cleaned from all dirt, mortar droppings etc. before applying the base plaster. The marble shall be fixed to the wall by bronze/copper cramps 5"x1.1/2"x1/4 " and Bronze pins 1/4" diameter x2" embedded firmly in to wall by cutting hole and grouting alternately stainless steel cramps and pins as per design shall be used. The load of one marble slab shall not be borne by the slab below. Joints between slabs shall be hair fine and filled with coloured cement to match the marble. The marble lining and dadoes shall be finally hand polished by Carborundum stone, buffing with polishing felt and cleaned with diluted oxalic acid wash.

7.9 Expansion and compression joints

These shall be clearly indicated on the shop drawings and formed of non-staining two parts polysulphide with polyethylene foam backing to full depth of screed in pavings.

In no instance shall expansion joints be less than 10 mm. Supporting corbels cover shall be recessed into the back of the above slab and not placed in the expansion joint. Expansion joint shall be kept completely free of all fixing materials and are to be inspected by the consultant prior to filling.

7.10 GRANITE STONE CLADDING WITH SPACE BETWEEN STONE AND WALL

Stone shall be of approved quality size, colour and thickness. The fixing detail shall be as described in item 7.11 above.

8.0 FINISHING

8.1 General

8.1.1 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.

8.1.2 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.

8.1.3 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.

8.1.4 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/Project Manager.

8.1.5 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.

8.2 Plaster Work

8.2.1 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.

8.2.2 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/Project Manager. 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.

8.2.3 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.

8.2.4 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.

8.2.5 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/Project Manager.

8.2.6 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.

8.3 White Washing

8.3.1 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.

8.3.2 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.

8.3.3 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.

8.3.4 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.

8.4 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.

8.5 Colour Washing

The mineral colours not affected by lime, shall be added to white wash. Indigo shall however, not be added. No colour wash shall be done until a sample of the colour

wash of the required tint or shade has been got approved from the Architect/Project Manager. The colour shall be of even tint or shade over the whole area.

A priming coat of white wash with lime or with whiting shall be applied. Two or more coats, shall then be applied on the entire surface till it represents a smooth and uniform finish.

Other specifications described in above shall apply in this case also.

8.6 Distempering

Dry distemper of required colour and (IS; 427 - 1965) of approved brand and manufacture shall be used. The shade shall be got approved from the Architect/ Project Manager before application of the distemper. The dry distemper colour as required shall be stirred slowly in clean water using 6 deciliters (0.6 litre) of water per Kg. of distemper or as specified by the makers. Warm water shall preferably be used. It shall be allowed to stand for atleast 30 minutes (or if practicable over night) before use. The mixture shall be well stirred before and during use to maintain an even consistency. Distemper shall not be mixed in larger quantity than is actually required for one days' work.

Preparation of surface

Before new work is distempered, the surface shall be thoroughly brushed free from mortar droppings and other foreign matter and sand papered smooth. Pitting in plaster shall be made good with plaster of Paris mixed with the colour to be used. The surface shall then be rubbed down again with a fine grade sand paper and made smooth. A coat of distemper shall be applied over the patches. The patched surface shall be allowed to dry thoroughly before the regular coat of distemper is applied.

A priming coat of whiting shall be applied over the prepared surface. No white washing coat shall be used as a priming coat for distemper.

Application

The treatment shall consist of a priming coat of whiting followed by the application of two or more coats of distemper till the surface shows an even colour.

Other specifications described as above shall apply in this case also.

8.7 Oil emulsion (Oil bound) distempering

Material: Oil emulsion (oil bound) distemper (IS:428-1929) of approved brand and manufacture shall be used. The primer used shall be cement primer or distemper primer. This shall be of same manufacture as distemper. The distemper shall be diluted with water or any other prescribed thinner in a manner recommended by the manufacturer. Only sufficient quantity of distemper required for days work shall be prepared. The distemper and primer shall be brought by the contractor in sealed tins in sufficient quantities, at a time to suffice for a fortnights work. The empty tins shall not be removed from the site of work, till this item of work has been completed and passed by the Architect/Project Manager.

Preparation of surface

Before new work is distempered, the surface shall be thoroughly brushed free from mortar droppings and other foreign matter and sand papered smooth. Pitting in

plaster shall be made good with plaster of Paris mixed with the colour to be used. The surface shall then be rubbed down again with a fine grade sand paper and made smooth. A coat of distemper shall be applied over the patches. The patched surface shall be allowed to dry thoroughly before the regular of distemper is applied.

A priming coat of whiting shall be applied over the prepared surface. No white washing coat shall be used as a priming coat for distemper.

Application

The priming coat shall be with distemper or cement primer, as required in the description of the item and as recommended by the manufacturer.

Note:

If the wall surface plaster has not dried completely cement primer shall be applied before distempering the walls. But if distempering is done after the wall surface is dried completely, distemper primer shall be applied.

Oil bound distemper is not recommended to be applied within six months of the completion of wall plaster.

After the primer coat has dried for atleast 48 hours, the surface shall be lightly sand papered to make it smooth for receiving the distemper, taking care not to rule out the priming coat. All loose particles shall be dusted off after rubbing. One coat of distemper properly diluted with thinner (Water or other liquid as stipulated by the manufacture) shall be applied with brushes in horizontal strokes followed immediately by vertical ones which together constitute one coat. The subsequent coats shall be applied in the same way.

For distemper 15 cm double bristled brushes shall be used. After each days work, brushes shall be thoroughly washed in hot water with soap solution and hung down to dry.

The specifications in respect of scaffolding protective measures and rute shall be as described under.

8.8 Cement Primer Coat

Cement primer shall be used as lease on wall finish of cement lime or lime cement plaster or asbestos cement surface before oil distemper paints are applied on them. Only approved cement primer shall be used. Primer coat shall be preferably applied by brushing and not by spraying.

Preparation of surface

The surface shall be thoroughly cleaned of dust, old white or colour wash by washing and scrubbing. The surface then be allow to dry for atleast 48 hours. It shall then be sand papered to give a smooth and even surface. 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 is dry.

Application

Cement primer shall be applied with a brush. Horizontal strokes shall be given first and vertical strokes shall be applied immediately afterwards. The entire operation will constitute one coat. The surface shall be finished as uniformly as possible leaving no brush marks. It shall be allowed to dry for atleast 48 hours, before oil emulsion paint is applied.

Rate shall include cost of all material and labour involved in all the operations described above including scaffolding.

8.9 Cement Paint

Cement paint shall be (conforming to IS: 5410 - 1969) of approved brand and manufacture.

Preparation of surface

The surface shall be thoroughly cleaned of all mortar dropping, dirt, dust, alga, grease and other foreign matter by brushing and washing. The surface shall be thoroughly wetted with clean water before the cement paint is applied.

Preparation of mix

Cement paint shall be mixed in such quantities as can be used up within an hour of its mixing as otherwise the mixture will set and thicken, affecting flow and finish.

Cement paint shall be mixed with water in two stages. The first stage shall comprise of 2 parts of cement paint and one part of water stirred thoroughly and allowed to stand for 5 minutes. Care shall be taken to add the cement paint gradually to the water and not vice versa. The second stage shall comprise of adding further one part of water to the mix and stirring thoroughly to obtain a liquid of workable and uniform consistency. In all cases the manufacturer's instructions shall be followed meticulously. The lid of cement paint drums shall be kept tightly closed when not in use, as by exposure to atmosphere the cement paint rapidly becomes air set due to its hydrophobic qualities.

Application

The solution shall be applied on the clean and wetted surface with brushes or spraying machine. The solution shall be kept well stirred during the period of application. It shall be applied on the surface which is on the shady side of the building so that the direct heat of the sun on the surface is avoided. The method of application shall be as per manufacturer's specifications. The completed surface shall be watered after day's work.

Water cement paint shall not be applied on surface already treated with white wash, colour wash distemper dry or oil bound, varnishes, paints etc. It shall not be applied on gypsum, wood and metal surfaces.

Rate shall include cost of all material and labour involved in all the operations described above including scaffolding.

8.10 <u>Painting</u>

i) Painting priming coat of wood surface

Primer for wood work shall be as specified in the description of the item. Surface to be primed shall be dry and thoroughly cleaned. All unevenness shall be rubbed down smooth with sand paper and shall be well dusted, knots, if any, shall be covered with preparation of red lead made by grinding red lead in water and mixing with strong glue sized and used hot. Appropriate wood filler material with same shade as paint shall be used where so specified.
The surface treated for knotting shall be dry before primer is applied. After the primer is applied the holes and indentation on the surface shall be stopped with glaziers putty or wood putty, stopping shall not be done before the priming coat.

ii) Painting priming coat on Iron & Steel surfaces

All rust and scales shall be removed by scrapping or by brushing with steel wire brushes. Hard skin of oxide formed on the surface of wrought iron during raking which becomes loose by rushing, shall be removed. All dust and dirt shall be thoroughly wiped away from the surface.

iii) Textured paint

The textured finish (SPECTRUM) to external surfaces of walls as per manufacturer's specification and approved by the Consultants including scaffolding etc. complete.

iv) Painting priming coat on plastered surface

The surface shall ordinarily not be painted shall be applied to get correct finish until it has dried completely. Before primer is applied, holes and undulations shall be filled up with plaster of Paris and rubbed smooth.

The primer shall be applied with brushes, worked well into the surface and spread even and smooth. Painting shall be done by crossing and laying off. The crossing and

laying off consists of covering the area over with paint, brushing the surface hard for the first time over and then brushing alternately in opposite direction, two or three times and then finally brushing lightly in a direction at right angles to the same. In this process, no brush marks shall be left the laying off is finished. The full process of crossing and laying off will constitute one coat.

Rate

Rate shall include cost of all labour and material involved the operations described above including scaffolding etc.

Painting with enamel paint (conforming to IS:2933 - 1975) and with synthetic enamel paint (conforming to IS:1932 - 1964).

The surface to be painted shall have received the approval of the Architect/Project Manager after inspection, before painting is commended.

Application

The number of coats including the under coat shall be stipulated in the item.

a) Under Coat

One coat of specified paint of shade suited to the shade of the top coat shall be applied and allowed to dry overnight. It shall be rubbed next day with the finest grade of wet abrasive paper to ensure a smooth and even surface, free from brush marks and all loose particles dusted off.

b) Top Coat

Tops coats of specified paint of desired shade shall be applied. Each coat shall be allowed to dry for not less than 24 hours and lightly rubbed down smooth with finest wet abrasion paper to get an even glossy surface. If, however, the surface is not satisfactory additional coats as required.

TERRACE WATER PROOFING WITH EPDM

Specification for Basement Roof Waterproofing with: EPDM RUBBERGARD
Description
Surface Preparation
Treatment of surface compaction, leveling and cleaning. Provision of smooth, hard and dry and clean concrete surface to receive RUBBERGARD waterproofing system. The Podium should have adequate slope to drain the storm/rain/irrigation water towards the provided drainage points.
Waterproofing 1.14 mm EPDM RUBBERGARD on Horizontal and Vertical roof surface.
HORIZONTAL AREA GEOTEXTILE : A layer of 150 gsm Geotextile is loose laid on Lean concrete/mother slab substrate. The geotextile membrane must be overlapped for 75mm. The overlapping joint may be secured by Stitching or Bonding Adhesive or hot air gun as convenient to the waterproofing applicator. **EPDM RUBBERGARD** : Laying 1.14 mm EPDM membrane confirming to above mentioned technical values is loose laid over the geotextile layer. The width of EPDM sheet should be minimum 6 meter or large as possible to minimize the number of joints. Adjacent sheet shall be laid in similar fashion with an overlap of minimum 100 mm . Min 75mm wide rubber polymers butyl splice tape having 100% solid content together with synthetic-rubber polymer primer having 16-18% solids, Specific Gravity 0.793 and Flash point-17.8 degree centigrade, should be used to make watertight Quick Seam between 2 EPDM membranes. **VERTICAL WALL :** The surface of wall shall be smooth, hard , dry and free from dust before applying treatment. 1.14mm thick EPDM RUBBERGARD confirming to above standards is fully bonded to the RCC substrate using FM approved solvent based Neoprene Bonding adhesive. All the insertions shall be treated with uncured EPDM. The treatment to be terminated at least at the height of 300mm above the maximum soil filling lavel using termination bar and appropriate fasteners. Water block sealant should be used on top edge behind membrane and lap sealant should be applied on the edges of termination detail. **UNCURED EPDM** flashing material factory laminated to splice tape should be used to flash inside and outside corners, pipes, drain outlets, scuppers and other penetrations or unusually shaped walls/details where the use of cured membrane flashing is not practical.
Root Barrier Layer and Protection before Soil Filling: 0.25 mm/ 250 Microns Poly Ethylene Sheet shall be laid all over EPDM Rubbermaid treatment. The PE Sheet should be overlapped for 1m. The joints of PE sheet should be hot welded. 50 mm screed for protection should be poured on the PE seet on the horizontal before Soil Filling and drainage system installation.

9.0 Waterproofing Underground Water Tank

Since the underground water tank is to be constructed in the water logged area, external tanking as mentioned in the basement shall be done.

Since water tank has different compartments then it will be necessary to waterproof the base and all walls including partition walls upto the full height so that water does not seep in through from one compartment to the other for which the use of TAPECRETE is done. TAPECRETE is a polymer modified cementitous material being manufactured in India in collaboration with M/s FRC Composities Ltd., Canada, Low permeability combined with a high resistance to cracking makes TAPECRETE an ideal lining material for waterproofing.

4 coats of TAPECRETE **–** each coat mixed with white cement in proportion 1:2 (1 part tapecrete and 2 parts of white cement) over a primer coat of neat cement admixed with chemical CH-9. All joints, corners, junction of pipe and concrete to be sealed with epoxy putty.

After the specification has been laid it is to be protected on the base with cement screed and on walls with cement sand plaster.

Waterproofing treatment is to be laid on reasonably smooth surfaces.

SPECIFICATION:

FOR BASE:

1. A layer of cement slurry mixed with chemical CH-9.

2. A layer of cement sand mortar 1:3 of about 25mm thickness (1 part cement & 3 parts of sand) mixed with chemical CH-9.

3. A layer of red sand stone of about 25mm to 35mm thickness and the joints of stone sealed with 1:1 cement sand mortar (1 part cement & 1 part sand) mixed with an admixture of chemical CH-9.

4. A layer of cement/sand mortar 1:4 of 20-25mm thickness (1 part cement: 4 parts sand) mixed with chemical CH-9 and stone grit of 15mm size just sprinkled over it.

FOR WALLS:

1. A layer of Red sand stone of about 25mm to 35mm thickness laid with a gap of about 12mm between the stone and wall and joint of stone sealed with neat cement mixed with chemical CH-9.
2. A layer of cement sand mortar 1:4 (1 part cement & 4 parts coarse sand) mixed with chemical CH-9 splashed on the exterior surfaces of stone **–** thickness about 12mm.

3. A layer of cement slurry mixed with chemical CH-9 filled in the gap between the stone and wall.

TRANSPARENT ACRYLIC WATER REPELLANT COAT

Surface Preparation: Surface to receive H-repeller must be structurally sound, clean and free from dust, dirt, chalk, oil, grease, efflorescence, window, loose paint and all other contaminants, which might interfere with adhesion. Surface must be prepared by water blasting, wire bushing, sand blasting or acid etching, cracks, spalled and damaged surface must be repaired prior to application of H-repeller.

Application: Apply H-repeller in a uniform, continuous film by brush, roller or spray. Most applications require a primer coat prior to applying the main coat. The primer coat should be dry to touch (typically one hour) before applying the subsequent main coat. The best method on all surfaces is by spray. The H-Repeller will achieve its maximum water repellence within 7-10 days. Work shall be carried out strictly by specialist applicators. Flat area shall be measured and paid for.

9.1 Injection method waterproofing treatment to the basement

a) **Horizontal Surface :** After the excavation and PCC levelling course, water proofing course shall be laid consisting of cement mortar 1:3 (1 cement:3 sand) and mixed with Acrylic water proofing chemicals and embedding aggregate by hand pack at random in two layers each of 25mm thick thus the total water proofing course shall be about 50mm thick. After the necessary curing, and fixing raft reinforce cement in partition provide 20 mm pipe inserts at 1.2 m c/c on both ways by tying it with reinforcement in such a manners to ensure that the bottom end of the pipe remain free from getting chocked and the length of the pipes shall be that of total thickness of the raft plus 25 mm above to protrude from the surface of the raft.

After concreting the raft, grouting Acrylic based waterproofing chemical mixed with neat cement slurry through the pipe inserts shall be carried and for the required period. The projected pipe ends shall be cut after grouting the mouths. The same procedure shall be adopted for all joints around the column wall joints.

b) **Vertical Surfaces** : The vertical surfaces shall be treated by making holes on the surface at 1.20 m centre to centre on both ways and also at all joints, corners and fixing nozzles of 20 mm dia pipe and inject Acrylic based chemicals mixed with neat cement slurry as explained above. After grouting the pipe, nozzles shall be removed and the packets shall be made good. The external surface of the walls shall be neatly plastered with cement mortar (1:3) admixed with Acrylic Chemicals in two layer of 12 to 15 mm thick each so that the average thickness shall be 25 mm.

The minimum proportion of the approved Acrylic based chemicals to be used in respect of ordinary portland cement shall be 1 kg of chemical with 100 kg of cement. The total operation has to be got done through approved agency with Ten years guarantee on stamped paper.

9.2 Roof and Sunken Area Waterproofing (BRICK BATCOBA)

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 is 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 upto 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.

9.3 Tapecrete Waterproofing

All the chasings or cuttings in the floors and walls shall be carried out prior to the commencement of the treatment. The prepared surface than shall be plastered with 20mm thick average with cement mortar 1:4 mix, mixed with `Cetrool' or acrylic based chemicals, or `CICO' admixture, all as per manufacturers' specifications. The plastering shall be carried out throughout the sunk portion and carried up to all sides of the walls up to ceiling level. The specialist then shall carry out `TAPECRETE' waterproofing treatment comprising of 3 coats of tapecrete with Ist coat of tapecrete mixed with white cement in proportion of 1:2 (1 part tapecrete : 2 white cement), 2nd coat of tapecrete mixed with white cement and silica sand in proportion of 1:2:1.5 (1 Tapecrete : 2 white cement : 1.5 white cement) , 3rd coat of tapecrete mixed with white cement in proportion of 1:2. 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 and to full height where tubs/wash basin and WC are being fixed. The depressed area then shall be filled with cement concrete mixed with "Cetrool" or "CICO or chemicals, surface finished even and to slope as required to receive tiles etc. Treatment for sunken portion shall be measured and paid for on Sqm basis for the Tapecrete work carried out. Plastering to walls, and concrete item will be measured and paid for separately.

9.4 Payment

All measurements will be for roof area only as measured on plain and no additional area for vertical tucking/embedding upto 300 mm height from top of finish will be included for payment. The contractors' rate will be inclusive of all these, to make the work complete.

10.0 ALUMINIUM WORK

10.1.1 GENERAL

a) This specification applies to the Aluminium Doors, Glazings and Curtain wall works to be executed by the contractor. It is to be read in conjunction with and subject to the general and special conditions of contract and in conjunction with the drawings, the schedule of rates and such other documents as may from time to time be agreed upon as comprising part of this contract.

This section covers the aspects of technical performance, product specifications, and execution and time warrantee for the works shown or specified.

b) The exterior wall system requirements shown by the details are intended to establish dimensions of units or modules and maintain the visual design concept as shown. The exterior wall system manufacturer shall be required to design the entire exterior building wall system, and to make whatever modifications of and addition to, the details as may be required to fulfill the performance requirements. The system consists of all anchors, window and spandrel framing members, glazing, sealants and other components required for a complete system as indicated on drawings including framing as required to support the system independently from the structural frame of the building. This also incorporate for openable windows.

10.1.2 APPLICABLE CODES AND STANDARDS

The specified reference standards are Codes which are intended to establish the quality of material and workmanship required for the works. more reference standards published in India and other countries may, in the sole judgment of the Owner's consultant, also be acceptable provided that the contractor furnishes sufficient data for the Owner's consultant to determine if the quality of materials and workmanship at least equals or exceeds the specified reference Codes.

Such other reference standards published by the following will be considered:

DIN	Deutsche Industrie Norman (German Standards)
AFNOR	Association Francaise de Normalisation (French Standard Institute)
BSI	British Standard Institute
ASTM	American Society for Testing and Materials
ANSI	American National Standards Institute

The following is the list of codes included for guidance and compliance with applicable portions only and the omission of any from the list does not relieve the contractor from compliance therewith.

IS:504-1963	Method of Chemical Analysis of Aluminium and its Alloys
IS:733-1975	Wrought Aluminium And Aluminium alloy Bars, Rods and Sections (for General Engineering Purposes)
IS:1081-1960	Code of Practice for Fixing and Glazing of Metal (Steel And Aluminium) doors, windows and ventilators
IS:1285-1975	Specifications for Wrought Aluminium and Aluminium Alloy, Extruded Round Tube and Hollow Sections (for General Engineering Purposes)
IS:1382-1981	Glossary of Terms Relating to Glass and Glassware
IS:1868-1982	Specification for Anodic Coatings on Aluminium and its Alloys.
IS:1948-1961	Specification for Aluminium Doors Windows and Ventilators (Incorp. Amend 1)
IS:1949-1961	Specification for Aluminium Windows for Industrial Buildings.
IS:2553-1990 (Part-1)	Safety Glass- Specification Part-1 General Purpose (third revision)
IS:2657-1964	Method for Tensile Testing of Aluminium and Aluminium Alloys Tube
IS:2673-1979	Dimensions for Wrought Aluminium And Aluminium Alloys, Extruded Round Tube
IS:2835-1987	Specification for Flat Transparent sheet Glass
IS:3203-1982	Method for testing Local Thickness of Electroplated Coatings. IS:3821-1973 Method for Determination of Mass of Aluminium Coating on Hot Dip Aluminized Iron or Steel Articles
IS:3965-1981	Dimensions for Wrought Aluminium and Aluminium Alloys, Bar, Rod and Section.
IS:5052-1969	Temper Designation of Aluminium and Its Alloys
IS:5523-1969	Methods of Testing Anodic Coatings on Aluminium
IS:5528-1969	Method of Testing Corrosion Resistance of Electroplated and Anodised Aluminium Coatings by Copper Accelerated Acetic Acid Salt Spray (CASS) Test
IS:6009-1970	Method for Evaluation of Results of Accelerated Corrosion Test.
IS:6012-1992	Measurement of Coating Thickness by Eddy Current Method (First Revision)
IS:6051-1970	Code for Designation of Aluminium and Its Alloys
IS:6477-1983	Dimension for Wrought Aluminium and Aluminium Alloys, Extruded Hollow Sections (first revision)
ASTM E 283	Air leakage through exterior windows,Curtain walls and Doors.
ASTM E 330	Structural performance of exterior window, Curtain walls and Doors under the influence of windloads
ASTM E 331	Water penetration of exterior windows, Curta in walls and Doors by uniform static air pressure differential.

Note: Wherever a reference to any standard appears in this specification and as above it shall be taken as a reference to the latest version of the standard.

10.1.3 SUBMITTALS

The following submittals are required:

a) Final design construction documents
b) Documentation showing conformance with performance criteria.
c) Shop Drawing: The tenderer shall submit detailed shop drawings within 15 days of acceptance of tender giving full details such as size of sections, coupling members and method of fixing anchorage, caulking, flashing etc. The tenderer shall also give all mechanical properties of all sections (e.g. perimeters, area, moments of inertia about bending axes, principal axes, principal moments of inertia, weights etc.) in a tabular form.
d) Design Analysis and Calculations: Include design calculations for review of design loads and member profiles.

e) Samples

i) Submit three samples of each required metal finish on 300mm (12 inch) long extrusion of the alloys to be used for the work. Where normal color and texture variations are to be expected, include two or more units in each sample, to show the range of such variation.

ii) Submit three samples of glass, 300mm (12 inch) square

iii) Provide two samples of typical fabricated sections showing joints, fastenings, quality of workmanship, hardware and necessary items before fabrication of the work proceeds.

iv) Glazing materials: 300 mm (12 inch) long samples each color and type required for glazing gaskets and sealant (Silicon/polysulphide) with its catalogue. All samples to be provided at no cost to the Owner or Architect.

f) Statement that the system meets the regulatory requirement of all statutory authorities having jurisdiction over the works in respect of fire, thermal aesthetics, mirroring effect, wind, loading, construction and warranty requirement, nothing in detail any exceptions. The statement /under taking shall be signed by a person authorised to legally represent the company.

10.1.4 MOCK-UP

Prior to beginning production, furnish and install a sample each for a full size mock up. Production of any item shall not proceed until the mock up is approved. Mock up with shop drawings shall be submitted for review prior to manufacturing. Use materials, fabrication and installation methods identical with those required for the project.

10.1.5 DESIGN RESPONSIBILITY AND PERFORMANCE REQUIREMENTS

Manufacturer shall be required to design systems to conform to design intent of profiles shown and design criteria specified, allowing for dead loads, wind pressures, thermal movements, earthquake, forces, erection loads and other conditions of usage which may reasonably be anticipated.

a) General:

The requirements shown by the details are intended to establish basic dimension of unit area modules, and provide site line of members. The manufacturer shall be required to design the entire system, and to make whatever requirements as may be required to fulfill the performance requirements to maintain the visual design concept as shown, including member size and alignment of component.

b) Wind Pressure

Fabricate exterior windows, Curtain walls , doors, to withstand the wind pressure shown or if not shown 200 kg/sqm on the face area, acting inward and 200 kg/sqm acting outward.

c) Temperature Variation

Thermal expansion and contraction movements resulting from an ambient temperature range of 2 to 48$_{o}$c. which may cause a metal surface with temperature variation.

d) Weather Resistance:

Fabricate exterior units with weather stripping to prevent from uncontrolled penetration of air and water under normal shear weather conditions.

e) Provision for Cleaning Gantry

Curtain Glazing mullions shall be capable of providing lateral restraint for the cables of maintenance cleaning gantry car having a total laden weight of 300 kg cradle deed load. Mullions strength shall be such that all loads applied during gantry operation are safely accommodated without damage or distortion of any element.

The manufacturer shall be responsible for methods and means of joining, fabrication, assembly, suspension, erection and compliance with all design criteria.

10.1.6 QUALITY ASSURANCE

a) General

The works shall conform to the Bureaun of Indian standard (BIS/IS) specifications for Aluminium glazings latest editions and in its absence the standards published in other countries.

b) Test units

It is required to perform all tests unless otherwise noted each portion of exterior wall system for both frame and glazing (fixed / openable) to the satisfaction of Construction Manager/ Architect.

c) Tests

Following tests are to be performed as per relevant standards.

i) Air infiltration test
ii) Water Penetration under Static Pressure
iii) Water Penetration under dynamic pressure
iv) Uniform load deflection test
v) Uniform load structural test
vi) Testing anchor's to resist seismic stresses without damage of any kind
vii) Wind resistance test
viii) Anodising testing.

Deflections shall be measured at the centre line members and at other critical points as deemed appropriate.

10.1.7 Site Conditions:

Manufacturer is to take field measurements prior to preparation of shop drawings and fabrication to ensure proper fitting of work. However, proceed with fabrication and coordination installation tolerances as necessary when field measurements might delay work.

10.1.8 Product handling, transport, storage and protection

Protect units and finishes in manner that will not cause damage or discoloration to units by covering exposed surface with thick layer clear transparent lacquer or self adhesive non- staining PVC tape before they are brought on site. The lacquer/tape shall be removed on completion of erection / wet civil work.

10.2 PRODUCTS

10.2.1 Materials

All materials and finishes are to be new and free from defects which may impair the appearance, strength, function and durability of the exterior window system and related construction of the external coverings.

a) Aluminium: The aluminium extruded sections shall conform IS designation HE/HV/9WP alloy with chemical composition and mechanical properties as per IS 733.1975 wall thickness to meet required loadings, with minimum for trim being 1.6mm. Test certificate for alloy and its extrusion from the manufacturer is required to be submitted by the contractor for its conformity.

b) Coating/Anodising: All aluminium sections shall be anodised or powder coated. Anodising shall conform to IS:1868-1982 and shall be of AC 25 grade with minimum thickness of 25 +/- 3 microns when measured as per IS 6012-1992 and the density shall be at least 32mg/square inch. All sections are to be matt anodised in colour as per sample available with the architects. The anodic coating shall be properly scalled by steam or boiling in de-ionised water as per IS 1868-1982. In case of powder coating, factory applied electrostatic powder coated sections 50+/- 5 micron will be considered for approval. Color consistency shall be accurate.

No visual variation in shade shall be permitted. The fabricator shall clearly indicate the shade variation tolerance as measured by standard equipment.

c) Structural and weather seal silicone sealant of GE or equivalent make duly approved is to be provided at shop and field joints which are sealed as part of assembly and installation procedures. It is to be applied appropriate for joint sizes, movement and substrate. Preshimmed tape shall be used against surfaces with grooves having backer rod at the groove of sufficient size and spacing to prevent shim migration.

Polysulphide sealant is to be applied between wall surface and sub frame in clear shade with preshimmed tape to prevent shim migration.

d) Glass and glazing

External glass shall be laminated glass of uniform appearance. Manufacture is to be specified and the product sample be verified.

Glass thickness shown is minimum thickness and shall be as per requirement to withstand loads criteria and their performance.

For all the glasses in glazing works 'edge distance' is to be clearly ascertained and maintained.

10.2.2 OTHER MATERIALS

a) Glazing Gaskets and Weathers trips :

EPDM extruded gaskets of hardner 40+5 durometer shore A for sponge gaskets, 75+5 durometer shore A for hollow profiles and 60+5 for solid profiles having exception for flame propagation are to be used.

All interior corners of gaskets where compatible with procedures are to be vulcanized. Provide gaskets with continuous splines for positive engagements in splins pockets in frame members.

Gasket profiles are to be designed taking into cognizance the glass edge pressures and the required edge distance.

b) Setting Blocks and Shims: Solid extruded EPDM with hardners 85+5 durometer shore A, minimum length 100mm minimum width corresponding to glass thickness.

c) Side Blocks: Solid extruded EPDM 55+5 shore A durometer blocks shall be of sufficient length to prevent point loading on glass.

d) Hardware: To be as per approved samples. Design and fixingof hardware shall be got approved by the Architects. The joining accessories shall be such that they do not cause any bimetallic action and shall be free from visible defects. Visible screws to be anodised made up of stainless steel.

e) Fasteners and anchor devices: Fasteners shall be concealed. Bolts and nuts of zinc-coated steel may be used for concealed assembly and anchorage provided no possibility of electrolytic action is present.

f) Mild steel supports sections of curtain walls should be hot dip galvanised and are to be separated by nylon or fibre gaskets, washers, sleeves and the like.

Fasteners used for bolting aluminium extrusions and their connecting members shall be aluminium or stainless steel. Fastener metals for joining various metal combinations shall be as follows:-

i) Aluminium to aluminium
Use only aluminium or stainless steel

ii) Aluminium to stainless steel
Use only stainless steel

iii) Stainless steel to stainless
steel Use only stainless steel

iv) All exposed fastener materials are to be in stainless steel and anodised, except required otherwise.

The Contractor is required to submit test certificates to prove compatibility of any materials or components as required by the Architect/Project Manager without any additional cost for its conformance to the relevant standards.

10.3 FABRICATION

The details shown are based upon standard details by one or more manufacturers. Similar details by other approved manufacturer will be acceptable provided they comply with the size requirements.

10.3.1 Shop Fabrication

a) Aluminium glazing shall be fabricated from extruded aluminum member of alloys specified. Complete the cutting, fitting forming, drilling and grinding of all metal work prior to cleaning, finishing, treatment and application of coatings. Remove arises from cut edges and ease edges and corners to a reading of approx..4mm.

b) Fabricate and shop assemble frame and sash members into complete window wall system as indicated along with anchors forsupport to the structure and with hairline joints where mechanical fasteners are used.

c) No bolts, screws or fastenings to impair independent movement.

d) Openable windows, typically, shall be fabricated to allow for inside glazing.

e) Miter all corners and mechanically stake over solid aluminium corner block, set and sealed in epoxy leaving hairline joinery and then seal weather tight.

f) Joinery methods must not discolor finish or be unsightly. Welding and brazing to comply with industry standards using system and rods for assembly and fabrication.

g) All frame corners and meeting rail intersection shall be made permanently leak proof.

h) Fasteners should be concealed except where otherwise shown, indicated or approved.

i) Provision for anchorage to the structure allowing for erection tolerances, thermal expansion and building deflections to make the unit vibration free with no visible or audible evidence of movement.

j) For glass to be fixed with minimum 'edge clearance' and 'bite' on glass, cutting is to be done precisely taking into consideration the recommendations by glass manufacturers, and design parameters alongwith performance requirement and gaskets and other practical considerations. Do not nip glass edges. Edges may be wheel cut or sawed and seamed at manufacturer's option. For glass to be cut at site, provide glass larger than required so as to obtain clean cut edges without the necessity of seaming or

nipping Grind, polish, and ease arises, nip or abrade glass after heat tempering.

k) For weather stripping by EPDM extruded gaskets provision shall be made to insure that water will not accumulate and remain in contact with the perimeter areas of glass and securely staking and joining at corners.

l) All glass pockets, fixed and moving, shall be weeped to provide positive drainage. Water shall be weeped to the exterior via frame weep slots protected by snap-in weep covers integral drips.

m) Except as otherwise indicated provide each continuous unit of framework and all accessory items as a packaged unit. Complete the fabricated assembly, finishing and all other work to the greatest extent possible in the factory before brought to the project site. Disassemble only to the extent necessary for transportation and installation.

n) After fabrication all glazing units (including disassembled parts) shall carry their designation viz., W-1, G-2 etc., size and location to be fixed well identified through self adhesive non staining removable PVC tape.

o) Fire stopping : Preformed incombustible insulation with retaining devices to meet the building code requirements .Insulation shall be of required depth to maintain required floor to floor fire sepration and of sufficient width to ensure that it fills all voids under compression.

10.4 EXECUTION

10.4.1 Inspection

Examine all parts of supporting structure, the areas and conditions under which work comprising of glazing items, and associated items are to be executed. Identify conditions detrimental to the proper and timely completion of the work and proceed with the work after getting the unsatisfactory conditions corrected, if any.

10.4.2 Co-ordination

Wherever possible, check actual opening in the construction work by accurate field measurements before fabrication and execution as well. Show recorded deviation if any, on final shop drawings and co-ordinate installation within fabrication tolerance to ensure proper fit of units / modules.

10.4.3 Preparation

Co-ordinate setting drawings, diagram templates, in structions and directions for the installation of anchorages which are to be embedded in concrete or masonry construction.

Bench marks for elevations and building line offset marks for alignment shall be established on each floor level by the contractor who shall be responsible for their accuracy. Should any error be found in their location the contractor so notify in writing and shall proceed in the affected areas after the errors have been corrected/rectified.

Aluminium subframes are to be provided of profiles and dimensions, indicated with mitered or coped corners, welded and dressed smooth and finish to match adjacent surfaces having concealed mechanical joint fasteners. The fixing of subframes shall be so co-ordinated with the civil works of the finishing works like plaster, base plaster and exterior stone work etc. are completed without any hindrance to main civil contractor. Dimensional variations, if any, in the building work shall be adjusted while

fixing sub frame in order to maintain the uniformity of glazing sizes, line, level and plumb.

Polysulphide sealant shall be applied alround of subframe between subframe and walls adjoining as per architectural drawings and manufacturer instructions through an experienced applicator only.

10.5 INSTALLATION

10.5.1 The installation of fabricated frames shall commence when called for by the project manager. This shall be properly co-ordinated with the finishing works.

10.5.2 Installation of frame works shall be done under direction and supervision of manufacturer's representative.

10.5.3 All parts of the work shall be erected, in plumb, level and true to line in proper alignment and in relation to established lines and grades and as shown on approved shop and or erection drawings without warp or rack of frames, sash or panels while positioning. Anchor securely in place. Separate corrodible metal surfaces from sources of corrosion or electrolytic action at points of contact with other materials.

10.5.4 Do not install defective component parts including warped, bowed, dented, abraded and broken members or glass with edge damage. Remove and replace members/unit which have been damaged prior to installation.

10.5.5 Do not cut, trim, weld or braze component parts during erection in any manner which would damage the finish, decrease the strength, or result in a visual imperfection or a failure in performance. Return component parts which require alteration to the shop for refabrication or for replacement by new parts.

10.5.6 Install component parts in level, plumb and true to line with uniform joints and reveals. Secure to structure with nonstaining and non corrosive shims, anchors, fasteners, spacers and fillars. use erection equipment which will not mar or stain finished surfaces or damage the component part in any way.

10.5.7 Erection Tolerances

a) Dimensional variation in the building frame and/or work surrounding or surrounding the work are as determined in the field by field measurement of the work in place.

b) The work shall be designed to accommodate all tolerances and anticipated dead and live load movement, creep, sway and torsion of the structure without any harmful effects. All parts of the work, when completed shall be within the following tolerance:

i) General: 3mm (1/8 inch) maximum deviation in any storey height or in any 3m (10 ft) vertical or angular run or in any 6m (20 ft) horizontal run.
6mm (1/4 inch) maximum deviation in any 12.2 m (40 ft) run, any direction.

ii) Locational: 3mm (1/8") maximum change in deviation for any member for any 3m (10 ft) run, any direction.
10mm (3/8 inch) total maximum deviation for any member at any location.

iii) Offsets: Limit offsets in the end to end and edge to edge alignments of adjoining and consecutive members, which form planes, continuous runs and profiles to the following:
Slope or curvature shall not exceed 1% when measured at intervals of 25mm (inch) in any direction.

-4mm (1/6 inch) maximum offset in flush alignments including alignments which are to be 13mm (1/2 inch) or less out of flush, and alignments which

separated 50mm (2 inch) or less by a reveal or protrusion in the plane of the wall .

-3mm (1/8 inch) maximum offset in alignments which are out of flush by more than 13.0mm (1/2 inch) or separated by a reveal or protrusion in the plane of the wall.

- Maximum offset from true alignment between two members abutting end-to-end, edge to edge in line or separated by less than 76mm, 0.8mm (shop and/or field joints 0< This limiting conditions shall prevail under both no load and full load conditions.

All aluminium frames shall be kept protected after installation by lacquer /tape to avoid scratches by Others.

10.5.8 Sealant

Sealing materials for sealing shall be structural or weather seal silicone sealant made by GE or approved equal used in strict accordance with the manufacturer's printed instructions and shall be applied only by applicators/mechanics specially trained or experienced in their use. Before applying sealant all dirt, dust, moisture and other foreign matter shall be completely removed from surfaces and shall be masked, when required, to maintain a clean and neat appearance. This shall provide a smooth finish surface.

10.5.9 Anchorage

Anchorage of the work to the structure shall be by approved methods in strict accordance with approved shop and/or erection drawings. Supporting framework and brackets shall be so designed as to provide three dimensional adjustments and accurate location of all components. After the unit is properly positioned all connections so designated on approved shop drawings shall be rigidly fixed by welding or other positive means.

Anchor component parts securely in place as shown by bolting, welding or other permanent mechanical attachment system which will comply with performance requirements and permit movements which are intended or necessary. Install slip joint lining wherever possible to ensure movement as in tended or necessary.

Wherever concealed contact surface or dissimilar materials before assembly or installation is existing or wherever there is the possibility of corrosive or electrolytic action, apply a suitable bituminous coating of approx. 0.76m (0.03 inch) dry film thickness or other suitable permanent separator.

10.5.10 Setting

Set all members and other members in a bed of compounder with joint fillers or gaskets to provide weather tight construction.

10.5.11 Cleaning, postponement, protection and security

a) Clean debris, dust and other substances caused during erection and keep the scrap, if any, away from thorough fare.

b) If directed by the project manager installation of the work shall be postponed in any areas so as to facilitate moving material into out of the building during construction.

c) The installed frames, sections and other components of aluminium glazing work in passages and exit(s) shall be kept protected and guarded for any damage by other working contractor's workmen in co-ordination with project manager.

10.6 GLAZING:

10.6.1 General:

Before glazing, openings shall be checked to see that they are square, plumb and true plane. If found otherwise glazing shall not proceed until proper corrections are made.

Inspect each piece of vision glass immediately before installation. Eliminate all which have edge damage or face imperfections.

10.6.2 Preparation

a) Comply with recommendations and requirements of glass manufacturers for installation of all glass.

b) Clean glazing channels, stop and rabbets to receive glazing materials of obstructions and deleterious substances which might impair the work.

c) Apply primer or sealer to joint surfaces wherever recommended by gasket manufacturer.

d) Clean with solvent all glass edges and faces which will be in contact with gaskets to remove all traces of cutting oils and other contaminates.

10.6.3 Setting blocks and spacers

Locate setting blocks of proper size at sill one quarter in from each end of the glass unless otherwise recommended by the glass manufacturer. Set blocks in this course of the heel-bead compound, if recommended.

Provide spacers for all glass sizes larger than a combined total of 1.27m or more for any two adjacent sides to separate glass from stops, except where continuous glazing gaskets are provided. Locate spacers no further than 600mm apart and no closer than 300mm to a corner. Place spacers opposite one another. Make bite of spacer on glass a nominal 6mm or greater.

10.6.4 Installation

Glasses shall be installed and blocked in such a manner as to assure proper glass bite on all sides. Correct glass sizes to insure glass bite shall be verified by measurement of the frames.

Protect glass from edge damage at all times during handling installa tion and subsequent construction operation.

Required glazing channel dimensions are to be provided as per glass size for necessary minimum 13mm bite on the glass, minimum edge clearance and adequate sealant thickness with reasonable tolerances.

Provide the correct glass size for each opening, within the tolerances and necessary dimensions by identified numbering from fabrication.
Perimeter clearance must be sufficient to avoid all point loading.

All structural silicone sealant to be applied by approved applicator of the manufacturer.

Provide watertight and airtight installation of each piece of glass so as to with stand temperature changes, wind forces and other effects as enumerated and specified.

10.6.5 CLEANING AND PROTECTION

Glass shall be protected from breakage immediately upon installation. Use streamers or ribbons suitably attached to framing and held free of the glass. Do not apply warning marking directly to the glass.

Protect glass and glazing materials during the construction period so that they will be without any indication of damage at the time of acceptance. Cover glass as required to protect it from abrasion and other activities that might abrade the surfaces.

Remove and replace glass which is broken, cracked, chipped or damaged in any way and from any source.

All debris caused by or incidental to the installation work shall be properly removed from the job site as the work progresses.

Wash glass on both faces (inside and outside) not more than 4 days prior to acceptance. Comply with instruction and recommendations of the glass manufacturer and glazing material for cleaning in each case. Remove manufacturer protective covering from frames when directed.

11.0 SPECIFICATIONS FOR STRUCTURAL STEEL WORK

11.1 General

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

11.1.2 Fabrication, erection and approval of steel structures shall be in compliance with :

- These General Specifications and IS : 800 - 1984
- Drawings and supplementary drawings to be supplied to the contractors during execution of the work.

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

11.1.4 In case of conflict between the Clauses mentioned here and the Indian Standards, those expressed in this specification shall govern.

11.2 Scope

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

11.3 Fabrication Drawings

11.3.1 The contractor shall prepare all fabrication and erection drawings on the basis of design drawings supplied to him and submit the same in triplicate to the Architect/Project Managers for review, Architect/Project Managers shall review and comment, if any, on the same. Such review, if any, by the Architect/Project Managers, does not relieve the contractor of any of his required guarantees responsibilities. The contractor shall however be responsible to fabricate the structural strictly conforming to specifications and reviewed drawings.

11.3.2 Fabrication drawings shall include the following :

- Member sizes and details
- Types and dimensions of welds and bolts
- Shapes and sizes of edge preparation for welding
- Details of shop and field joints included in assemblies.

Bill of material

- Quality of structural steels, welding electrodes, bolts, nuts and washers etc. to be used.

- Erection assemblies, identifying all transportable parts and sub-assemblies, associated with special erection instructions, if required.

- Calculations where asked for, for approval.

11.3.3 Connections, splices etc. other details not specifically detailed in design drawings shall be suitably given on fabrication drawings considering normal detailing practices and developing full member strengths. Where asked for calculations for the merit shall also be submitted for approval.

11.3.4 Any alternate design or change in section is allowed when approved in writing by the Architect/Project Manager.

11.3.5 However if any variation in the scheme is found necessary later, the contractor will be supplied with revised drawings. The contractor shall incorporate these changes in his drawings at no extra cost and resubmit for review.

11.3.6 Architect/Project Managers/Consultants review shall not absolve the contractor of his responsibility for the correctness of dimensions, adequacy of details and connections. One copy will be returned reviewed with or without comments to the contractor for necessary action. In the former case further three copies of amended drawings shall be submitted by the contractor for final review.

11.3.7 The contractor shall supply three prints each of the final reviewed drawings to the Architect/Project Managers within a week since final review, at no extra cost for reference and records.

11.3.8 The Architect/Project Managers will verify the correct interpretation of their requirements.

11.3.9 If any modification is made in the design drawing during the course of execution of the job, revised design drawings will be issued to the contractor. Further changes arising out of these shall be incorporated by the contractor in the fabrication drawings already prepared at no extra cost and the revised fabrication drawings shall be duly got reviewed as per the above Clauses.

11.4 Materials

11.4.1 Rolled Sections

The following grades of steel shall be used for steel structures :

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

11.4.2 Welding Materials

Welding electrodes shall conform to IS: 814.

Approval of welding procedures shall be as per IS: 823.

11.4.3 Bolts, Nuts & Washers

Bolts and nuts shall be as per IS: 1367 and tested as per IS:1608. It shall have a minimum tensile strength of 44 Kg/mm^2 and minimum elongation of 23% on a gauge length of 5.65 (A- Original cross sectional area of the gauge length).
Washers shall be as per IS: 2016.

11.4.4 All materials shall conform to their respective specifications. The use of equivalent or higher grade or alternate materials will be considered only in very special cases subject to the approval of the Architect/Project Managers in writing.

11.4.5 Receipt & Storing of Materials

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

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

Structures with surface defects such as pitting, cracks, laminations etc. shall be rejected if the defects exceed the allowable tolerances specified in relevant standards or as directed by the Architect/Project Managers.

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

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

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

The contractor may use alternative materials as compared to design specification only with the written approval of the Architect/Project Managers.

11.4.6 Material Tests

The contractor shall be required to produce manufacturer's quality certificates for the materials supplied by the contractor. Notwithstanding the manufacturer's certificates, the Architect/Project Managers may ask for testing of materials in approved test houses. The test results shall satisfy the requirements of the relevant Indian Standards.

Whenever quality certificates are missing or incomplete or when material quality differs from standard specifications the contractor shall conduct all appropriate tests as directed by the Architect/Project Managers at no extra cost.

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

11.5 Fabrication

Fabrication shall be in accordance with IS: 800 Section V in addition to the following:

Fabrication shall be done as per approved fabrication drawings adhering strictly to work points and work lines on the same. The connections shall be welded or bolted as per design drawings. Work shall also include fabricating built up sections.

Any defective material used shall be replaced by the contractor at his own expense, care being taken to prevent any damage to the structure during removal.

All the fabricated and delivered items shall be suitably packed to be protected from any damage during transportation and handling. Any damage caused at any time shall be made good by the Contractor at his own cost.

Any faulty fabrication pointed out at any stage of work shall be made good by the contractor at his own cost.

11.5.1 Preparation of Materials

Prior to release for fabrication, all rolled sections warped beyond allowable limit shall be pressed or rolled straight and freed from twists, taking care that an uniform pressure is applied.

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

The sections shall be straightened by hot working where the Architect/Project Managers so direct and shall cooled slowly after straightening.

Warped members like plates and flats may be used as such only if wave like deformation does not exceed L/1000 but limited to 10 mm (L-Length).

Surface of members that are to be joined by lap or fillet welding or bolting shall be even so that there is no gap between overlapping surfaces.

11.5.2 Marking

Marking of members shall be made on horizontal pads, of an appropriate racks or supports in order to ensure horizontal and straight placement of such members. Marking accuracy shall be atleast $\pm$ 1 mm.

11.5.3 Cutting

Members shall be cut mechanically (by saw or shear or by oxyacetylene flame).

All sharp, rough, or broken edges, and all edges of joints which are subjected to tensile or oscillating stresses, shall be ground.

No electric metal arc cutting shall be allowed.

All edges cut by oxyacetylene process shall be cleaned of impurities prior to assembly.

Cutting tolerances shall be as follows :

a) For members connected at both ends $\pm$ 1 mm.
b) Elsewhere $\pm$ 3 mm.

The edge preparation for welding of members more than 12 mm thick shall be done by flame cutting and grinding. Cut faces shall not have cracks or be rough.

Edge preparation shall be as per IS : 823 - 1964.

11.5.4 Drilling

Bolts holes shall be drilled.

Drilling shall be made to the diameter specified in drawings.

No enlarging of holes filling, by mandrolling or oxyacetylene flame shall be allowed. Allowed variations for holes (out-of-roundness, eccentricity, plumb-line deviation) shall be as per IS:800.

- Maximum deviation for spacing of two holes on the same axis shall be $\pm$ 1 mm.

- Two perpendicular diameters of any oval hole shall not differ by more than 1 mm.

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

11.5.6 Preparation of Members for Welding

Assembly of structural members shall be made with proper jigs and fixtures to ensure correct positioning of members (angles, axes nodes etc.)

Sharp edges, rust of cut edges, notches, irregularities and fissures due to faulty cutting shall be chipped or ground or filled over the length of the affected area, deep enough to remove faults completely.

Edge preparation for welding shall be carefully and accurately made so as to facilitate a good joint.

Generally no special edge preparation shall be required for members under 8 mm thick.

Edge preparation (bevelling) denotes cutting of the same so as to result in V, X K or U seam shapes as per IS: 823.

The members to be assembled shall be clean and dry on the welding edges. Under no circumstances shall wet, greasy, rust or dirt covered parts be assembled. Joints shall be kept free from any foreign matter likely to get in to the gaps between members to be welded.

Before assembly the edges to be welded as well as adjacent areas extending for atleast 20 mm shall be cleaned (until metallic polish is achieved).

When assembling members, proper care shall be taken of welding shrinkage and distortions, as the drawing dimensions cover finished dimensions of the structure.

The elements shall be got checked and approved by the Architect/Project Managers or their authorized representative before assembly.

The permissible tolerances for assembly of members preparatory to welding shall be as per IS: 823-1964.

After the assemble has been checked, temporary tack welding in position shall be done by electric welding, keeping in view finished dimensions of the structure.

11.5.7 Welding procedures

Welding shall be carried out only by fully trained and experienced welders as tested and approved by the Architect/ Project Managers. Any test carried out either by the Architect/ Project Managers of their representative or the inspectors shall constitute a right by them for such tests and the cost involved thereon shall be borne by the contractor himself.

Qualification tests for welders as well as tests for approval of electrodes will be carried out as per IS: 823. The nature of test for performance qualification of welders shall be commensurate with the quality of welding required on this job as judged by the Architect/Project Managers.

The steel structures shall be automatically, semi-automatically or manually welded.

Welding shall begin only after the checks mentioned in Clause 5.1 to 5.6 have been carried out.

The welder shall mark with his identification mark on each element welded by him. When welding is carried out in open air, steps shall be taken to protect the

face of welding against wind or rain. The electrodes, wire and parts being welded shall be dry.

Before beginning the welding operation, each joint shall be checked to ensure that the parts to be welded are clean and root gaps provided as per IS: 823.

For continuing the welding of seems discontinued due to some reason, the end of the discontinued seem shall be melted in order to obtain a good continuity. Before resuming the welding operation, the groove as well as the adjacent parts shall be well cleaned for a length of approx. 50 mm.

For single butt welds (in V, 1/2 V or U) and double butt welds (in K, double U etc.) the rewelding of the root is mandatory but only the metal deposit on the root has been cleaned by back gouging or chipping.

The welding seams shall be left to cool slowly. The contractor shall not be allowed to cool the welds quickly by any other method.

For multi-layer welding, before welding the following layer, the formerly welded layer shall be cleaned metal bright by light chipping and wire brushing. Backing strips shall not be allowed.

The order and method of welding shall be so that -

- No unacceptable deformation appears in the welded parts.

- Due margin is provided to compensate for contraction due to welding in order to avoid any high permanent stresses.

The defects in welds must be rectified according to IS: 823 and as per instruction of Architect/Project Manager.

11.5.8 Weld Inspection

The weld seams shall satisfy the following :

- shall correspond to design shapes and dimensions.

- shall not have any defects such as cracks, incomplete penetration and fusion, under-cuts, rough surfaces, burns, blow holes and porosity etc. beyond permissible limits.

During the welding operation and approval of finished elements, inspections and tests shall be made as shown in annexure-B.

The mechanical characteristics of the welded joints shall be as in IS: 823.

11.5.9 Preparation of Members for Bolting

The members shall be assembled for bolting with proper jigs and fixtures to sustain the assemblies without deformation and bending.

Before assembly, all sharp edges, shavings, rust dirt, etc. shall be removed.

Before assembly, the contacting surfaces of the members shall be cleaned and given a coat of primer as per IS: 2074.

The members which are bolt assembled shall be set according to drawings and temporarily fastened with erection bolts (minimum 4 pieces) to check the coaxiality of the holes.

The members shall be finally bolted after the deviations have been corrected, after which there shall not be gaps.

Before assembly, the members shall be checked and got approved by the Architect/Project Managers.

The difference in thickness of the sections that are butt assembled shall not be more than 3% or maximum 0.8 mm whichever is less. If the difference is larger, it shall be corrected by grinding or filling.

Reaming of holes to final diameter or cleaning of these shall be done only after the parts have been check assembled.

As each hole is finished to final dimensions (reamed if necessary) it shall be set and bolted up. Erection bolts shall not be removed before other bolts are set.

11.5.10 Bolting up

Final bolting of the members shall be done after the defects have been rectified and approval of joints obtained.

The bolts shall be tightened starting from the centre of joint towards the edge.

11.5.11 Planing of Ends

Planing of ends of members like column ends shall be done by grinding when so specified in the design.

Planing of butt welded members shall be done after these have been assembled, the spare edges shall be removed with grinding machines or files.

The following tolerances shall be permitted on members that have been planed.

- On the length of the member having both ends planed, maximum $\pm$ 2 mm with respect to design.
- Level differences of planed surfaces, maximum 0.3 mm.
- Deviation between planed surface and member's axis maximum 1/1500.

11.5.12 Holes for Field Joints

Holes for field joints shall be drilled in the shop to final diameters and tested in the shop, with trial assemblies.

When three-dimensional assembly is not possible in the shop, the holes for field joints may be drilled in shop and reamed on site after erection, on approval by the Architect/Project Managers.

For bolted steel structures, trial assembly in shop is mandatory.

The tolerance for spacing of holes shall be $\pm$ 1 mm.

11.5.13 Tolerances

All tolerances regarding dimensions, geometrical shapes and sections of steel structures, shall be as per Annexure B, if not specified in the drawing.

11.5.14 Marking for Identification

All elements and members prior to despatch for erection shall be shop marked.

The members shall be visibly marked with a weather proof light coloured paint. The size and thickness of the numbers shall be chosen as to facilitate the identification of members.

For the small members that are delivered in bundles or crates, the required marking shall be done on small metal tags securely tied to the bundle, while the crates shall be marked directly.

Each bundle or crate shall be packed with members for one and the same assembly; in the same bundle or crate, general utility members such as bolts, quests etc. may be packed.

All bill of materials showing weight, quality and dimension of contents shall be placed in the crates.

The members shall be marked with a durable paint, in a visible location, preferably at one end of the member so that these may be easily checked during storage and erection.

All members shall be marked in the shop before inspection and acceptance.

When the member is being painted, the marking area shall not be painted but bordered with white paint.

The marking and job symbol shall be registered in all shop delivery documents (transportation, for erection etc.)

11.5.15 Shop Test Pre-assembly

For steel structures that have the same type of welding the shop test pre-assembly shall be performed on one out of every 10 members minimum.

For bolted steel structures, shop test pre-assembly is mandatory for all elements as well as for the entire structure in conformity with Clause 5.12.

11.6 Shop Inspection and Approval

11.6.1 General

The Architect/Project Managers or their representative shall have free access at all responsible times to the contractors fabrication shop and shall be afforded all reasonable facilities for satisfying himself that the fabrication is being undertaken in accordance with drawings and specifications.

Technical approval of the steel structure in the shop by the Architect/Project Managers is mandatory.

The contractor shall not limit the number and kinds of tests, final as well as intermediate once, or extra tests required by the Architect/Project Managers.

The contractor shall furnish necessary tools, gauges, instruments etc. and technical non-technical personnel for shop tests by the Architect/Project Managers, free of cost.

11.6.2 Shop Acceptance

The Architect/Project Managers shall inspect and approve at the following stages:

The following approvals may given in shop:

- Intermediate approvals of work that cannot be inspected later.
- Partial approvals
- Final approvals

Intermediate approval of work shall be given when a part of the work is preformed later :

- Cannot be inspected later
- Inspection would be difficult to perform and results would not be satisfactory.

Partial approval in the shop is given on members and assemblies of steel structures before the primer coat is applied and includes :

- Approval of materials
- Approval of field joints
- Approval of parts with planed surfaces
- Test erection
- Approval of members
- Approval of markings
- Inspections and approvals of special features, like Rollers, loading platform mechanism etc.

During the partial approval, intermediate approvals as well as all former approvals, shall be taken in to consideration.

11.6.3 Final approval in the Shop

The final approval refers to all elements and assemblies of the steel structures, with shop primer coat, ready for delivery from shop to be loaded for transportation, or stored.

The final approval comprises of :

- Partial approvals
- Approval of shop primer coat
- Approval of mode of loading and transport
- Approval of storage (for materials stored)

11.7 Painting and Delivery

11.7.1 Preparation of parts for shop painting

Painting shall consist of providing one coat of red oxide zinc chromate primer to steel members before dispatch from shop.

Primer coat shall not be applied unless:

- Surface have been wire brushed, cleaned of dust, oil, rust etc.

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

- The surface to be painted is completely dry.

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

- Members and parts have been inspected and accepted

- Welds have been accepted.

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

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

- Surfaces bearing markings

- Other surfaces indicated in the design.

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

- Planed surfaces
- Holes for links

The surfaces that are to be embedded or in contact with the concrete shall be given a cost of cement wash.

The surfaces which are in contact with the ground, gravel or brick work and subject to moisture, shall be given bituminous coat.

The other surfaces shall be given a primer coating.

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

If specified elsewhere, in the schedule of quantities, the contractor shall paint further coats of red-oxide after erection and placing in position of the steel structures.

11.7.2 Packing, transportation, delivery

After final shop acceptance and marking, the item shall be packed and loaded for transportation.

Packing must be adequate to protect item against warping during loading and unloading.

Proper lifting devices shall be used for loading, in order to protect items against warping.

Slender projecting parts shall be braced with additional steel bars, before loading, for protection against warping during transportation.

Loading and transportation shall be done in compliance with transportation rules.

If certain parts cannot be transported in the lengths stipulated in the design, the position and type of additional splice joints shall be approved by the Architect/Project Managers.

Items must be carefully loaded on platforms of transportation means to prevent warping, bending or falling during transportation.

The small parts such as fish plates, quests etc. shall be securely tied with wire to their respective parts.

Bolts, nuts and washers shall be packed and transported in crates.

The parts shall be delivered in the order stipulated by the Architect/Project Managers and shall be accompanied by document showing :

- Quality and quantity of structure or members
- Position of member in the structure
- Particulars of structure
- Identification number job symbol.

11.8 Field Erection

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

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

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

11.8.4 Approval by the Architect/Project Managers or their representatives at any stage of work does not relieve the contractor of any of his required guarantees of the contract.

11.8.5 Storage and preparation of parts prior toerection

The storage place for steel parts shall be prepared in advance and got approved by the Architect/Project Managers before the steel structures start arriving from the shop.

A platform shall be provided by the Contractor near the erection site for preliminary erection work.

The contractor shall make the following verifications upon receipt of material at site.

- for quality certificates regarding materials and workmanship according to these general specifications and drawings.

- Whether parts received are complete without defects due to transportation, loading and unloading and defects, if any, are well within the admissible limit.

For the above work sufficient space must be allotted in the storage area.

Steps shall be taken to prevent warping of items during unloading.

The parts shall be unloaded, stored and stored so as to be easily identified.

The parts shall be stored according to construction symbol and markings so that these may be taken out in order or erection.

The parts shall be at least 150 mm clear from ground on wooden or steel blocks for protection against direct contact with ground and to permit drainage of water.

If rectification of members like straightening etc. are required, these shall be done in a special place allotted which shall be adequately equipped.

The parts shall be clean when delivered for erection.

11.8.6 Erection & Tolerances

Erection in general shall be carried out as required and approved by the Architect/ Project Managers.

Positioning and levelling of the structure, alignment and plumbing of the stanchion and fixing every member of the structure shall be in accordance with the relevant drawings and to the complete satisfaction of the Architect/Project Managers.

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

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

In case there be any deviations regarding positions of foundations or anchor bolts, which would lead to erection deviations, the Architect/Project Managers shall be informed immediately. Minor rectifications in foundations, orientation of bolts holes etc. shall be carried out as part of the work, at no extra cost.

The various parts of the steel structure shall be so erected so to ensure stability against inherent weight, wind and erection stresses.

The structure shall be anchored and final erection joints completed after plan and elevation positions of the structural members have been verified with corresponding drawings and approved by the Architect/Project Managers.

The bolted joints shall be tightened so that the entire surface of the bolt heads and nuts shall rest on the member. For parts with sloping surfaces tapered washers shall be used.

11.9 Final acceptance and handing over the structure

11.9.1 At acceptance, the contractor shall submit the following documents:

- Shop and erection drawings - either in tracings or reproducible.

- 4 copies of each of the following :
- shop acceptance documents
- Quality certificate for structural, plates, etc. (electrodes, welding wire, bolts, nuts, washers etc.)
- List of certified welders who worked on erection of structures.
- Acceptance and intermediate control procedure of erection operations.

11.9.2 Approval by the Architect/Project Managers at any stage of work does not relieve the contractor of any of his required guarantees of the contract.

11.10 Method of Payments

11.10.1 Payment for steel work shall be made on basis of admissible weight of the structure accepted, the weight being determined as described in such Clause 11.10.2 below :

The rate for supply, fabrication and erection, shall include cost of all handling and transportation to Owner's store/site o work where supply and fabrication only are involved, trimming, straightening, edge preparation, preparation and getting reviewed of fabrication drawings, and providing one or more coat of Red-oxide zinc chromate primer as specified in the schedule of quantity.
In the case, Owner supplies materials the rate shall include cost of steel materials taking delivery of the materials, from owner's store all handling and re-handling, loading and unloading, transport to site or work, returning of surplus materials to owner's stores etc. complete as well as the cost of all handling and transport, scaffolding, temporary supports, tools and tackles, touching up primer coat, grouting etc.

11.10.2 The actual lengths installed shall be measured and the weight of structural material/plate shall be calculated wherever necessary on the basis of IS handbook. If sections are different from IS section, then manufacturers handbook shall be adopted. No allowance in weights shall be made for rolling tolerance.

11.10.3 Sections built out of plates, structural shall be paid on the actual weight incorporated except for gussets which will be paid on the weight of the smallest rectangle enclosing the shape. No deductions shall be made for skew cuts in rolled steel sections.

11.10.4 Welds, bolts, nuts, washers, etc. shall not be measured. Rate for structural steel work shall be deemed to include the same.

11.10.5 No other payment either for temporary works connected with this contract or for any other item such as welds, shims, pacing plates etc. shall be made. Such item shall be deemed to have been allowed for in the rate quoted for steel work.

11.11 Grouting of Pockets

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

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

11.12 Tolerances allowed in the erection of plant building without cranes

The maximum tolerances for line and level of the steel work shall be $\pm$ 3.00 mm on any part of the structure. The structure shall not be out of plumb more than 3.5 mm on each 10 M. section of height and not more than 7.0 mm per 30 M. section.

These tolerances shall apply to all parts of the structure unless the drawings issued for erection purposes state otherwise.

ANNEXURE – A

INSPECTION

Inspection	**Coverage**	**Procedure**	**Evaluation findings and remedy of defect**
Inspection of weld seam appearance	All welds	Naked eye or lens	All faulty welds shall be rectified.
Checking of sizes	At least one for each weld seam	Ordinary measuring instruments (rule, templates)	Should faulty weld be found all welds shall be checked & all defects shall be rectified.
Mechanical tests for welding procedure performance and electrodes		As per IS : 823	As per IS : 823

ANNEXURE - B

INADMISSIBLE WELD DEFECTS AND TOLERANCE ALLOWED FOR WELDS

Defects	**Detailing of sketching of defects**	**Allowed tole-rance and remedy of defects**	**Cause of defects**	**Mode of finding defects**
Unsatisfactory appearance	uneven width rugged	at discretion cut weld & reweld	uneven welding progress, voltage fluctuations, varying Arc length, negligence, inexperience welder	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	excessive melting wrong handling of electrode.	visual inspection
Pits		not allowed cut & reweld	wrong welding technique	visual inspection
Surface cracks		not allowed cut & reweld	Great stresses, sudden cooling, wrong type of electrode.	visual inspection
Incorrect Sectional Dimensions a) Depth b) Weld		b1 = ± 2mm b2 = ± 2mm b = ± 1mm c = ± 1mm Chisel & grind.	negligence	Template checking

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Insufficient	For weld lengtyhs 11 + 5mm for 12 + 10mm for shorter seams cut and reweld or complete to length	Negligence	Rule checking
Back cuts	if 0.5mm for 10mm & C 1mm for 10mm replace relevant members	Burned material excessive melting	Visual Inspection
Surface porosities	Max. 5% of weld seam area cut and reweld	Frequent interruptions or welding electrodes inadequately covered	Visual inspection

INADEQUATE APPEARANCE OF WELD MAY BE ALLOWED IF NO OTHER DEFECTS THAT MIGHT DIMINISH WELD STRENGTH ARE PRESENT. SECTIONAL WELD SHAPE MUST COMPLY WITH DESIGN INDICATIONS. NO CONCAVE WELDS SHALL BE ALLOWED FOR SPECIFIED CONVEX WELDS, OR VICE VERSA. TOLERANCE FOR CONCAVITY OR CONVEXITY OF WELDS SHALL BED. 1 x a ("a" BEING THE HEIGHT OF THE TRIANGLE WITHIN THE SECTION SHOWN), BUT NOT MORE THAN 0.6 mm.

12.0 CONCRETE PAVEMENTS

12.1 Processing and Construction

12.1.1 Weather and Seasonal Limitations

Unless special precautions as specified are taken, concreting shall not be done during extreme weather conditions, e.g., during monsoon months, and when atmospheric temperature in shade is above 40°C or below 4°C. For guidelines for construction of cement concrete pavements in hot weather, reference may be made to IRC : 61-1976.

12.1.2 Preparation of base

The base to receive the cement concrete shall be checked for line, grade and cross-section as spelt out in Chapter 7. All irregularities beyond the permitted tolerances shall be rectified as specified.

Where concrete is to be laid over an absorbent surface, the latter shall be kept moist in saturated surface dry condition or covered over by a water-proof kraft/Polyethylene sheeting as specified so as to prevent absorption of water from the concrete mortar.

12.1.3 Fixing of formwork

The formwork shall be of correct shape, free from bends and kinks and sufficiently rigid to maintain its shape and position under the weight and working conditions of the laying and compacting equipment, It shall be set to true lines and levels and securely fixed in position to prevent any subsequent disturbance during compaction. Trueness of the formwork from the specified profile shall be checked and any deviation greater than 3mm in 3m rectified. No deviation shall, however, be permitted at the joints.

12.1.4 Manufacture and Placement of Concrete

Shall be carried out as specified in 'Concrete Work'.

12.1.5 Adequate surcharges of concrete shall be given over the desired finished level. The amount of surcharge shall be determined in the field by actual trial. The surcharge shall be uniform over the entire area and the concrete as spread shall be to the same camber and slope as the required finished surface.

12.1.6 The concrete shall be compacted fully using vibrating screeds and/or internal vibrators as specified. The vibrating screeds and internal vibrators shall conform to IS :2506 and IS:2505 respectively. Compaction shall be so controlled as to prevent excess mortar and water working on to the top due to over vibration.

12.1.7 During compaction, any low or high spots shall be made up by adding or removing concrete.

12.1.8 After longitudinal floating has been completed but while concrete is still plastic, the slab surface shall be tested for trueness with a 3m straight edge in accordance with the procedure set forth in Chapter 7. Any depressions or high spots showing departure from the true surface shall be immediately rectified. High spots shall be cut down and refinished. Depressions shall be enlarged to about 8-10 cm and filled up with fresh concrete, compacted and finished. All the above operations shall be completed within 75 minutes/ (60 minutes in hot weather) of mixing.

12.1.9 After correcting the surface for profile but just before the concrete becomes non-plastic, the surface shall be finished by belting, brooming and edging as specified.

12.1.10 Where the slab is to be laid in two layers, the second layer shall be placed within 30 minutes of compaction of the lower layer.

12.2 Control of Concrete Strength

12.2.1 The strength of concrete shall be ascertained either from cube or beam Specimens as specified. For this purpose, during the progress of work, cube/ beam samples shall be cast for testing at 7 and 28 days. Sampling and testing shall be in accordance with IS : 1199 and 516 respectively. Frequency of testing shall be as indicated in Table.

TABLE

S.No.	TEST	TEST METHOD	MINIMUM DESIRABLE FREQUENCY
1.	Workability of fresh concrete	IS : 1199	One test per 10 m^3
2.	Concrete strength	IS : 516	3 cube/beam samples as specified for each age of 7days and 28 days for every 30 m^2 of concrete.
3	Core strength on hardened concrete.	IS : 516	2 cores for every 30 m^3 of concrete.

12.2.2 Acceptance of the work shall not be based on a single test result but on statistical basis, such that the lower control limit calculated for a tolerance level of 1 in 15 test results, shall not be lower than the specified minimum strength. The lower control limit is given by the mean value of the set of tests minus 1.61 times the standard deviation. The work shall be taken to meet the specification requirements when the lower control limit is above the specified strength. Where the above requirements are not met with or where the quality of concrete or its compaction is suspected, the actual strength of the hardened concrete in the pavement shall be checked as set forth.

12.3 Joints

12.3.1 All materials required for the joints viz., tie bars, dowel bars, expansion joint filler boards and joint sealing compound shall be checked for specification Requirements before their incorporation in the work. The sealing compound Shall conform to IS : 1834.

Dowel bars shall be placed parallel to each other and parallel to the surface and centre line of the pavement. The permissible tolerances in this regard shall be:

± 1 mm in 100 mm for dowels of 20 mm and smaller diameters ; ± 0.5 mm in 100 mm for dowels of diameter greater than 20 mm.

The dowel assembly shall be firmly secured in place to prevent dislocation during concreting. Bulkheads in pairs with tight fitting holes for dowels may be used for this purpose.

All joints spaces and grooves shall conform to the specified lines and dimensions.

During concreting special care shall be exercised to dowels and in the vicinity of joints. Care shall also be taken to ensure that joints do not cause any discontinuity in the riding surface.

At the end of the curing period before opening to traffic, the joint grooves shall be cleaned thoroughly and sealed as specified in IRC : 57-1974. Care shall be taken to see that the sealing compound is not heated beyond the specified temperature.

12.4 Curing of concrete

Curing shall commence soon after the finished pavement surface can take the weight of the wet burlap, cotton or jute mats normally employed for initial curing, without leaving any marks thereon. The mats shall extend beyond the pavement edges at least by 0.5 m and be constantly wetted. Initial curing shall be for 24 hours or till the concrete is hard enough to permit labour operations without damage.

Final curing, after the removal of the mats, etc., shall be carried out by wet earth, ponding of water or other means specified. Where water is used for curing it shall be ensured that the entire pavement surface is kept well saturated throughout the specified curing period. Where water is scarce or pavement is on a steep gradient, impervious membrane curing shall be adopted as per details specified.

12.5 Checking the Quality of Hardened Concrete

Soon after the initial curing period, the surface of the hardened concrete shall be checked for surface regularity in accordance with the procedure as indicated in IRC : 15-1970.

Where the strength of concrete tested vide Clause 12.4 falls below the specified limits or where the quality of concrete or its compaction is suspected, the actual strength of the hardened concrete shall be ascertained by carrying out tests on cores cut from the hardened concrete. Frequency of testing shall be as indicated in Table. Crushing strength tests on cores shall be corrected for height-diameter ratio and age for obtaining the corresponding cube strength at 28-days in accordance with the procedure given in IRC : 15-1970. The corrected test results shall then be analysed for conformity with the specification requirement on the lines of Clause 12.4.

12.6 Reinforcement

Reinforcing steel, where required to be provided, shall be checked for specification requirements before incorporation in the pavement. Reinforcement shall be placed as specified. Due care shall be taken to ensure that the reinforcement is not displaced during concreting operations.

13.0 TECHNICAL SPECIFICATION FOR SANITARY FIXTURES

13.0 **SCOPE OF WORK:**

13.1 Work under this section shall consist of furnishing all material and labour necessary and required to completely install all sanitary fixtures, chromium plated fittings and accessories as given in the Tender or as per requirement.

13.2 Without restricting to the generality of the foregoing the sanitary fixtures & C.P. fitting shall include the following:

a) Sanitary fixtures
b) Chromium plated fittings
c) Stainless steel sinks
d) Accessories e.g toilet paper holders, coat hook, dispenser etc.
e) Mirror

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

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

13.5 **GENERAL REQUIREMENTS:**

13.5.1 All materials shall be new and of best quality confirming to specification and subject to the approval of the NFL. Wherever particular makes are mentioned, the choice of selection shall remain with the Owner.

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

13.5.3 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, and drawings. Accessories shall include proper fixing arrangement, brackets, nuts, bolts, screws and required connection pieces.

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

13.5.5 Porcelain sanitary ware shall be glazed vitreous china of first quality free from warps, cracks and glazing defects confirming to I.S. 2556.

13.5.6 Sinks for pantry or kitchen shall be stainless steel or as specified in the specification.

13.5.7 Chromium plated fittings shall be cast brass chromium plated of the best quality approved by the Owner.

13.5.8 All Appliances, fittings and fixtures shall be fixed in a neat workmanlike manner true to level and heights shown on the drawings and in accordance with the 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, Filing Plaster, Paint, insulation or terrace shall be made good by the Contractor at his own cost.

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

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

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

c) All appliances shall be securely fixed. Manufacturers' 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.

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

e) Appliances shall be fixed so that water falls to the outlet.

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

13.5.10 Sizes of Sanitary fixtures given in the Specifications or in the tender are for identification with reference to the catalogues of makes considered. Dimensions of similar models of other makes may vary within + 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.

13.5.11 EUROPEAN WATER CLOSET:

a) WC shall be single or double symphonic wash down type floor/ wall mounted set, flushed by means of a flushing cistern.
b) Each W.C. set shall be provided with a solid plastic seat of colour given in the tender, rubber buffers and chromium plated hinges. Plastic seat shall be so fixed that it remains absolutely stationary in vertical position without falling down on the W.C.
c) Flush pipe/bend shall be connected to the Water Closet by means of suitable rubber adapter.
d) Wall hung Water Closet shall be supported by C.I. chair.

13.5.12 URINALS:

a) Urinals shall be lipped type half stall white glazed vitreous china of best quality and size as mentioned in the Schedule of Quantities.
b) Half stall urinals shall be provided with 15 mm dia C.P. spreader, 32 mm dia C.P. domical waste and C.P.cast brass bottle trap with pipe and wall flange and shall be fixed to wall by C.I. brackets, C.I. wall clips and CP brass screws as recommended by manufacturer complete as directed by Architect/Consultants.
c) Flushing for urinals shall be by means of no hand operation, infra-red electric flush valve with complete kit of plumbing, infra-red photo cells, solenoid valve. 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.
d) Flush pipes shall be GI pipes concealed in wall chase but with chromium plated bends at inlet and outlet or as given in Schedule of Quantities. These shall be measured and paid for separately.
e) GI waste pipes shall be provided for urinals wash basin, sink.

13.5.13 URINAL PARTITIONS:

a) Urinal partitions shall be white glazed vitreous china of size specified in the Schedule of Quantities.
b) 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 Architect/Consultants.

13.5.14 WASH HAND BASIN:

a) Wash basins shall be coloured or white glazed vitreous china of best quality, size, shape and type specified in the Tender.
b) Each basin shall be provided with painted MS angle or CI brackets and clips and the basin securely fixed to wall. 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 Architect/Consultants.
c) Each basin shall be provided with 32 mm dia C.P. waste of standard pattern with pop-up waste or rubber plug and chain as specified in the Schedule of Quantities, 32 mm dia C.P. brass bottle trap and angle valve with C.P.pipe to wall and flange as given in the schedule of quantities.
d) Each basin shall be provided with single hole mixing fitting or as specified in the Schedule of Quantities.
e) Basins shall be fixed at proper heights as shown on drawings. If height is not specified, the rim level shall be 80 cms or as directed by Architect/Consultants.

13.5.15 SINKS :

a) Sinks shall be white glazed fireclay or vitreous china or stainless steel or any other material as specified in the Schedule of Quantities.

b) Each sink shall be provided with M.S. or C.I. 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 40 mm dia C.P. waste with china 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 Architect/Consultants.

c) Each sink shall be provided with hot and cold mixing fittings or CP taps as specified in the schedule of quantities.

13.5.16 MIRRORS:

a) Mirrors shall be electro coated copper 5.5mm thick of approved make. The size shall be as specified in the Schedule of Quantities or as shown on the drawings. The image shall be clear and without waviness at all angles of vision.
b) Mirrors shall be provided with backing of 12mm thick marine plywood or 6mm thick cement asbestos sheet fixed with CP brass semi round headed screws and cup washers or CP brass clamps as specified or instructed by Architect/Consultants.

13.5.17 TOILET PAPER HOLDER:

Toilet paper holder shall be of CP brass, powder coated/S.S. heavy duty of approved make and colour or as specified.

13.5.18 HAND DRIER:

a) The hand drier shall be no touch operating type with solid state time delay to allow user to keep hand in any position.

b) 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.

c) The hand drier shall be of wall mounting type suitable for 230V, single phase, 50 Hz, AC power supply.

13.5.19 TOILETS FOR DISABLED (IF PROVIDED IN THE Common Facility):

a) Where specified in washroom facilities designed to accommodate physically handicapped, accessories should be provided as directed by the Project Manager.

b) Stainless steel grab bars of required size suitable for concealed or exposed mounting and non-slip gripping surface shall be provided in all washrooms to be used by physically handicapped as directed by the Project Manager.

13.5.20 ACCESSORIES:

a) All C.P. bib taps and Angle valves shall be quarter turn-type washerless fittings. The angle valve shall be provided with stainless steel mesh filter.

b) Contractor shall install all chromium plated stainless steel and powder coated accessories as shown on the drawings or directed by Architect/Consultants and given in the Schedule of Quantities.

c) All C.P. accessories shall be fixed with C.P. brass half round head screws and cut washers in wall with rawl plugs or nylon sleeves and shall include cutting and making good as required or directed by Architect/Consultants.

d) Joints/ gaps between all sanitary appliances/fixtures and the floor/ walls shall be caulked with an approved mildew resistant sealant, having anti-fungal properties, of colour and shade to match that of the appliance/ fixture and the floor/ wall to the extent possible.

13.5.21 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 with a pressure of 38mm water gauge for minimum of 3 minutes in accordance with BS:5572.

13.5.22 SOIL, WASTE, VENT & RAIN WATER PIPES:

Work under this section shall consist of furnishing all labour, materials, equipments and appliances necessary and required to completely install all soil, waste, vent, Rain water pipes, drainage sump riser and fittings as required by the drawings and given in the Tender. Without restricting to the generality of the foregoing, the soil, waste, vent pipe rain water system shall include the following :-

a) Horizontal and Vertical C.I. soil, waste and vent pipes, and fittings, Drip seal joint, clamps and connection to fixtures.
b) Floor and Urinal traps, Floor Drain, Cleanout plugs, G.I. inlet fittings and CP brass/stainless steel grating.
c) Waste pipe connection from all fixtures e.g wash basins, sinks, urinals, kitchen equipments and plant room equipment
d) UPVC/CI Rain water pipes/CI(LA) Drainage/Sewage Sump Pump Riser. uPVC sump vent pipe and fitting.
e) All materials shall be new of the best quality conforming to IS codes and specifications and subject to the approval of NFL.
f) PVC Pipes of desired sizes conforming to latest revisions of IS:13592 may also be used for SOIL, WASTE, VENT & RAIN WATER Pipes
g) Pipes and fittings shall be fixed truly vertical, horizontal or in slopes as required in a neat workman like manner. Access doors for fittings and cleanouts shall be so located that they are easily accessible for repair and maintenance.

13.5.23 CENTRIFUGAL CAST IRON (SPUN) PIPE :

Soil, waste, vent and anti-siphonage pipes, fittings and accessories shall be centrifugal cast iron (spun). All pipes shall be straight and smooth and their inside free from irregular bore, blow holes, cracks and other manufacturing defects. Pipes shall be centrifugally cast (spun) iron soil pipes conforming to IS: 3989-1984.

Standard weight, dimensions and pig lead required for joints shall be as follows:

For pipes conforming to IS:3989-1984 (centrifugally spun C.I pipes)
Tolerance: as per IS:3989-1984

13.5.24 FITTINGS:

a. Fittings shall conform to the same Indian Standard (IS : 3989-1984) for pipes. Contractor shall use pipes and fittings of matching specifications.

b. Fittings shall be of the required degree of curvature with or without access door as detailed in the drawings or as directed.

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

13.5.25 FIXING:

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

b) Horizontal pipes running along ceiling shall be fixed on 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 rest on them.

c) 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 by the Contractor at his own cost to restore the surfaces.

13.5.26 CLAMPS :

a. Holder bat clamps shall be of standard design fabricated from MS flats 40x3mm thick and 12mm dia MS rod and 6mm nuts and bolts; painted with two coats of black bitumen paint before fixing. The clamps shall be fixed in cement concrete 1:2:4 mix (1 cement : 2 sand : 4 stone aggregate 20mm nominal size) blocks 100x100x100mm deep.

b. Where holder bat clamps are to be fixed in RCC column or slotted angles, walls or beam they shall be fixed with 40x3mm flat iron "U" type clamps with anchor fasteners of approved design.

c. Structural clamps shall be fabricated from MS structural members e.g. rods, angles, channels, flats as per detailed drawing or as directed. Contractor shall provide all nuts, bolts, welding material and paint the clamps with one coat of red oxide and two or more coats of black enamel paint to give an even shade.

d. Wherever MS clamps are required to be anchored directly to brick walls, concrete slabs, beams or columns, nothing extra shall be payable for clamping arrangement, RCC block and making good with cement concrete 1:2:4 mix (1 cement : 2 sand : 4 stone aggregate 20mm nominal size) as directed by the Architect/Consultants.

13.5.27 TRAPS :

a) Floor Trap:

Floor trap shall be cast iron 'P' Trap with or without vent horn (deep seal with an effective seal of 50 mm). In case of Sunken slab in the Toilets, the trap and waste pipes shall be set in cement concrete blocks of size 300mm x 300mm and of required depth, firmly supported on the structural floor. The blocks shall be in 1 :2 :4 mix (1 cement : 2 coarse : 4 stone aggregate 20mm nominal size) and extended to 40mm below finished floor level. Contractor shall provide all necessary shuttering and centering for the blocks at no extra cost.). In case of flat slab instead sunken slab in the Toilets, Contractor shall provide all sleeves, openings, hangers, inserts during the construction for fixing the floor traps and etc.

b) Urinal Trap:

Urinal traps shall be cast iron P or S traps with or without vent horn and set in cement concrete block specified under Clause 7.1 Floor Trap without extra charge.

c) Floor Trap Inlet/GI Inlet Fitting:

Traps and connections shall ensure free and silent flow of discharging water. Where specified, Contractor shall provide a special type cast iron or G.I. inlet hopper without or with one or two or three inlet sockets to receive the waste pipe. Joint between G.I. waste pipe and hopper inlet socket shall be Drip seal joint. Hopper shall be connected to a CI 'P' or 'S' trap with at least 50mm seal (hopper and traps shall be paid for separately). Floor trap inlet hoppers and the traps shall be set in cement concrete blocks/and supports as specified under clause 7.1 Floor trap above without extra charge.

13.5.28 CP/S.S. GRATING :

Floor and Urinal Traps, Floor drain shall be provided with 80-125 mm square or round C.P./stainless steel grating with rim of approved design and shape. Minimum thickness shall be 4 mm or as per IS.

13.5.29 JOINTING :

Soil, waste, vent and anti-siphonage pipes shall be jointed with Lead joint/Drip seal joint as mentioned in the BOQ.

The following minimum procedures shall be complied with while making the pipe joints :-

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

b) The pipes shall be cut square with sharp tools.

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

d) Any deformed ends shall be re-rounded.

e) It shall be ensured that the pipe ends shall enter the fittings and sockets to full depth of the jointing area.

f) The pipe work shall be assembled in a manner such that it does not entail making of joints in restricted locations.

g) Each metal pipe spigot shall be centered with three lightly wedged pieces of hardwood or folded lead.

h) The jointing surfaces shall be cleaned to remove any coatings or cutting oils, etc

13.5.30 CI (LA) PIPE AND FITTING:

Sump Pump discharge Pipe/Rain Water horizontal header/soil waste header running at Basement ceiling/Rain Water Pipe running underground shall be centrifugally cast [spun] iron pressure pipe {class LA] conforming to IS 1536:2001

13.5.31 CLEAN OUT PLUGS :

Contractor shall provide cast brass clean out plugs as required. Clean out plugs shall be threaded and provided with key holes for opening. Clean out plugs shall be fixed to the pipe by a GI socket and lead caulked joint.

13.5.32 WASTE PIPE FROM APPLIANCES:

a. Waste pipe from appliances e.g. washbasins, sinks and urinals etc. shall be of Galvanized-iron (GI) heavy duty (class 'c') conforming to IS: 1239 Part I.

b. All pipes shall be fixed in gradient towards the outfalls of drains. Pipes inside a toilet room shall be in chase unless otherwise shown on drawings. Where required pipes may be run at ceiling level in suitable gradient and supported on structural clamps as directed by the Architect/Consultants. Spacing for the clamps shall be 3000mm for vertical runs and 2400mm for horizontal runs.

c. Pipes shall be galvanized steel tubes conforming to IS : 1239 (Heavy Class) and quality certificates shall be furnished. Pipes shall be provided with all required malleable fittings conforming to IS: 1879 e.g. tees, couplings, bends, elbows, unions, reducers, nipples, plugs etc. All GI waste pipes shall be terminated at the point of connection with the appliance with an outlet of suitable diameter. Pipes in chase shall be painted with two coats of black bitumestic paint and exposed pipes with one coat of red oxide primer and two or more coats of synthetic enamel paint.

13.5.33 TECHNICAL SPECIFICATION OF WC PAN CONNECTOR:

a) The WC pan connector shall be flexible/soft and shall be made of single body construction with integral fins, made from EVA (Ethgl vingl Acetate). The pan connector must confirm to BS 5627: 1984. The pan connector must be supplied with one seal made of TPE (Thermo plastic Elastomeric). The pan connector must be supplied with factory fitted spring loaded seal guard.

b) The connector shall not be allowed to come in contact with mineral oil, grease, putty or any compound containing mineral oil or grease.

c) The pan connector must be scared away from direct sun light and flames

FIXING

Soil pipe must be reasonably clean and smooth and the diner surface, in case the soil piping is C.I material then supplier supplied bush/adaptor shall be used. The connector socket is pushed fully home on to the pan spigot, the reafter the WC is placed in position gently pushing the fitment to ensure that the connector end filts into the spigot of the pipe. The pan connector must be pushed in such and way as to ensure that the seats and fins turn inward to ensure proper sealing.

13.5.34 CEMENT CONCRETE:

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 (1 cement: 2 coarse sand: 4 stone aggregate 12 mm size) 75 mm in bed and around. When pipes are running well above the structural slab, the encased pipe shall be supported with suitable cement concrete pillars of required height at intervals of 1.8 m.

13.5.35 PAINTING:

a) Soil, waste, vent and anti-siphonage pipes in any exposed location in shafts, pipe spaces etc. shall be painted with two coats of primer and two or more coats of synthetic enamel paint of colour as specified to given an even shade.

b) Pipes shall be painted with paint of approved quality and shade in accordance with approved pipe colour code.

c) GI waste pipes in chase shall be painted with two coats of bitumen paint. Exposed pipes shall be painted with two or more coats of synthetic enamel paint over two coats of etch primer.

d) CI soil and waste pipes below ground and those covered in cement concrete shall not be painted.

13.5.36 CUTTING AND MAKING GOOD HOLES/ CHASES :

Pipes shall be fixed and tested as the building work proceeds. Contractor shall provide all necessary holes, cut outs and chases in structural members as the 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 aggregated 20mm nominal size) or cement mortar 1 : 2 (1 cement : 2 coarse sand) as directed by the Architect/Consultants and the surface restored as in original condition to the entire satisfaction of the Architect/Consultants at no extra cost.

13.5.37 TESTING:

a) Testing shall be done in accordance with IS : 1172 and IS:5329 except as may be modified herein under.

b) 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.

c) 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 Architect/Consultants. The total head in the stack shall be 4.5m at the highest point of the section under test. The period of test shall be two (2) hours minimum as directed by the Architect/Consultants. If any leakage is visible, the defective part of the work shall be cut out and made good.

d) The Contractor shall test all vent pipes by a smoke testing machine. Smoke shall be pumped into the stack after plugging all inlets and connections. The stack shall then be observed for leakages and all defective pipes and fittings removed or repaired as directed by the Architect/Consultants.

d) A test register shall be maintained and all entries signed and dated by Contractor and Architect/Consultants. A proforma of the proposed test register shall be submitted to the Architect/Consultants for approval.

e) All pipes in wall chase or meant to be chased or buried shall be hydro tested before the chase is plastered or the pipe encased or buried.

13.5.38 UPVC PIPES & FITTINGS:

a) UPVC PIPE AND FITTINGS FOR RAIN WATER DISPOSAL SYSTEM :

Rain water pipe shall be UPVC SWR Type A conforming to IS : 13592-1992.Dimension of SWR Pipe Fittings shall be as per DIN 19531 and DIN 19534 and conforms to IS : 14735-1999.Rubber ring shall be conforming to IS : 5382.

b) DIMENSION OF SWR PIPES CONFORMING TO IS : 13592-1992.

c) Maximum Support Distance in Meter :

S.No.	Size (mm)	Horizontal Support Distance (m)	Vertical Support Distance (m)
1	40	0.4	1.2
2	50	0.5	1.5
3	75	0.75	2.0
4	110	1.1	2.0
5	160	1.6	2.0

For testing, seal hermetically at all opening below the top of the section to be tested. The water level shall then be raised to a height of not less than 3m above the highest point of the section being tested or as the inspection offer may direct. Every joint shall be carefully examined for leaks.

d) TECHNICAL DETAIL:

[1] Dimension of Unplasticized PVC Pressure Pipes [Ring Fit/Ring Tight Rigid PVC Pipes [As per IS : 4985-2000].

13.5.39 WATER SUPPLY SYSTEM :

Work under this section consists of furnishing all labour, materials equipment and appliances necessary and required to completely install for water supply system (Cold Water Supply + Hot Water Supply) as required by the drawings, specified hereinafter and given in the Schedule of Quantities.

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

a) Water supply works inside the building etc. including connection to vertical stack / main line.

b) Pipe protection and painting.

c) Connections to all fixtures etc.

d) Ball valve/butterfly valve/Non Return valve.

e) All materials shall be new and of the best quality conforming to specifications. All works executed shall be to the satisfaction of the Project Manager.

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

g) Short or long bends shall be used on all main pipe lines as far as possible. Use of elbows shall be restricted for short connections. As far as possible all bend shall be formed by means of a hydraulic pipe bending machine for pipe up to 65 mm dia.

h) Pipes shall be laid in a manner as to provide as far as possible easy accessibility for repair and maintenance and shall not cause obstruction in shafts, passage etc.

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

j) Pipe shall be securely fixed to wall and ceiling by suitable clamps at intervals specified.

13.5.40 GI /PVC PIPES, FITTINGS AND VALVES:

a) All pipes inside the buildings and where specified, outside the building shall be galvanized steel tubes/PVC conforming to IS: 1239/4985 of Class specified. When Class is not specified they shall be Heavy Class.

b) Fittings shall be of malleable cast iron galvanized of approved make. Each fitting shall have manufacturer's trade mark stamped on it. Fittings for G.I pipes shall include couplings, bends, tees, reducers, nipples, unions, bushes etc. Fittings etc. shall conform to IS : 1879. (Part 1 to X) 1987.

d) Pipes and fittings shall be jointed with screwed joints using Teflon tape suitable for water pipes. Care shall be taken to remove burr from the end of the pipe after cutting by a round file. All pipes shall be fixed in accordance with layout and alignment shown on the

drawings. Care shall be taken to avoid air pockets. Necessary vents and drains shall be provided at all high and low points respectively. G.I pipes inside toilets shall be fixed in wall chases well above the floor. No pipes shall be run inside a sunken floor as far as possible. Pipes may be run under the ceiling or floors and other areas as shown on drawings.

Pipe Support :

Pipes clamps, supports, hangers, pipe support shall be factory made galvanized MS steel or alternatively galvanized after fabrication to suit site requirement pipe supports. G.I/CPVC pipes in shafts and other locations shall be supported by G.I clamps of design approved by the Architect/Consultants. Pipes in wall chases shall be anchored by iron hooks. Pipes at ceiling level shall be supported on structural clamps fabricated from MS structural. Pipes in shafts shall be supported on slotted angles/ channels as specified/ as directed.

Anchor Fasteners :

All pipe supports, hangers and clamps to fixed on RCC walls, beams, columns , slabs and masonry walls 230 mm thick and above by means of galvanized expandable anchor fasteners in drilled holes of correct size and model to carry the weight of pipes. Drilling shall be made only by approved type of power drill as recommended and approved by manufacturer of the anchor fasteners. Failure of any fastening devices shall be the entire responsibility and contractor shall redo or provide additional supports at his own cost. He shall also compensate the owner for any damage that may be caused by such failures.

Unions :

Contractor shall provide adequate number of unions on all pipes to enable easy dismantling later when required. Unions shall be provided near each gunmetal valve, stop cock or check valve and on straight runs as necessary at appropriate locations as required for easy dismantling and/ or as directed by Architect/Consultants.

Flanges :

Flanged connections shall be provided on pipes as required for maintenance/ ease in dismantling or where shown on the drawings, all equipment connections as necessary and required or as directed by the Architect/Consultants. Connections shall be made by the correct number and size of the GI nuts/ bolts as per relevant IS Standards and made with 3mm thick insertion rubber washer/ gasket. Where hot water or steam connections are made insertion gasket shall be of suitable high temperature grade and quality approved by the Architect/Consultants. Bolt hole dia for flanges shall conform to match the specification for CI sluice valve as per IS:780. Gaskets shall conform to IS:11149.

Trenches :

All G.I pipes below ground shall be laid in trenches with a minimum cover of 600mm. The width and depth of the trenches shall be as follows:

S. No.	Dia of pipe	Width of trench	Depth of trench
1	15mm to 50mm	300 mm	750 mm
2	65mm to 100mm	450 mm	1000 mm
3	150mm and above	600 mm	1200 mm

Sand Filling:

GI pipes in trenches shall be protected with fine sand 150mm all around before filling in the trenches.

Painting:

All pipes above ground shall be painted with one coat of red oxide and two coats of synthetic enamel paint of approved shade and quality. Pipes shall be painted to standard colour code specified by the Architect/Consultants.

Pipe protection:

Where specified in the schedule of quantities all pipes in chase below ground shall be protected against corrosion by applying two coats of bitumen paint wrapping with polythene tape and finishing with one more coat of bitumen paint.
PVC Pipes of desired sizes conforming to latest revisions of IS: 4985 can also be used for Water Supply lines.

The contractor on the award of the work, shall prepare detailed working drawings, showing the cross-section, longitudinal sections, details of fittings, locations of isolating and control valves, drain valves and all pipe support, structural supports. He must keep in view the specific openings in buildings and other structures through which pipes are designed to pass.

a) 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.

b) Pipe supports shall be of steel, adjustable for height and primer coated with rust preventive paint and finish coated back. Where pipe and clamps are of dissimilar materials a gasket shall be provided in between. Spacing of pipe supports shall not exceed the following:

S.No.	Pipe Size	Spacing between Supports
1	Upto 12 mm	1500 11500 mm (1.5m)
2	15 to 150 mm	2000 22000 mm (2.0 m)
3	150 mm & over	2500 2 2500mm (2.5m)

c) Vertical risers shall be parallel to walls and column lines and shall be straight and plumb. Risers passing from floor to floor shall be supported at each floor by clamps or collars steel structural supports attached to pipe and with a 15 mm thick rubber pad or any resilient material. Where pipes pass through the terrace floor, suitable flashing shall be provided to prevent water leakage. Risers shall have a suitable clean out at the lowest point and air vent at the highest point.

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

e) All pipe work shall be carried out in a workmen 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 particular area work shall be carried out in one trench.

f) Cut outs in the floor slab for installing the various pipes 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.

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

h) All pipes shall be accurately cut to the required sizes in accordance with relevant codes and burrs removed before laying. Open ends of the pipes shall be closed as the pipe is installed to avoid entrance of foreign matter. Where reducers are to be made in horizontal runs, eccentric reducers shall be used for the piping to drain freely. In other locations, concentric reducers may be used.

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13.5.42 BALL VALVES:

All ball valves shall be heavy duty of approved make. Valves shall have suitable for test pressure of 25 Kg/Sqcm. Ball valves shall conform to the following specifications.

Size	Construction	Ends
15 to 50 mm	Bronz body S.S. Working Part stainless steel balls, spindle, teflon seating and gland packing	Screwed

13.5.43 BUTTERFLY VALVE:

All butterfly valves shall be heavy duty cast iron of approved make. The valves shall be suitable for 15 Kg/Sqcm test pressure & shall conform to the following specifications Butterfly valve shall be of best quality conforming to IS: 13095:

13.5.44 NON-RETURN VALVES:

All non-return valves shall be provided as shown in the drawings conforming to relevant Indian Standards and in accordance with the following specifications.

	Size	**Construction**	**Ends**
13.5.45 TECHNICAL SPECIFICATION OF PRESSURE REDUCING VALVE:	Upto 50 mm. 65 mm and above	Gun metal Gun metal/cast iron	Screwed Flanged

PRV in brass housing (DZR) with G ¼ "pressure gauge connection part, spring bonnet with adjustable opening having adjustable knob for pressure adjustments. The diaphragm shall be in fibre- reinforced NBR and seals in NBR. The adjustment spring shall not be in touch with water at any given time.

WORKING:

The force of the diaphragm shall operate against the force of an adjustable spring. The inlet pressure shall have no influence in either the opening or closing the valve, hence, inlet pressure fluction shall not influence the outlet pressure shall remain constant at all times.

ADJUSTMENT OF PRESSURE:

The knob fitted on top of the PRV shall be turned toward (-) or (f) sign to reduce/ increase the outlet pressure as desired.

RANGE:

a. Inlet pressure : Max 16 bar /As per requirement

b. Outlet pressure : 1.5 to 6 bar adjustable

c. Operating temperature : Max to Degree C

d. Maximum pressure drip : 1 bar

13.5.46 AUTOMATIC AIR VENT (AAV):

a) Automatic air vents, shall be furnished at the top of main water risers, supply and return pipes.

b) A shut-off valve shall be provided at the inlet of each automatic air vent. The outlet shall be piped to the nearest drain.

c) Air Release Valves shall be capable of automatically releasing accumulated air from a fluid system while that system is in operation and under pressure.

d) To assure drop tight shut-off, a viton orifice button shall be used to seal the valve discharge orifice when the valve is in a closed position. The orifice diameter will be sized for use within a given operating pressure range to insure maximum discharge capacity.

13.5.47 DUCTILE IRON PIPES & FITTINGS

DI pipes (Class K9) and fittings (Class 12) shall be in accordance with IS 8329 and IS 9523 respectively. Pipes and fittings shall be procured from reputed manufacturers. The *Contractor* or their authorized representative shall at all reasonable times have free access to the place where the pipes and fittings are manufactured for the purpose of examining and testing the pipes and fittings and for witnessing the test and manufacturing.

The pipes and fittings shall be stripped, with all precautions necessary to avoid warping or shrinking defects. The pipes and fittings shall be free from defects. In the case of spigot and socket pipes and fittings the socket shall be without the center ring.

In the case of flanged pipes, the flanges shall be at the right angles to the axis of the pipe and machined on face. The bolt holes shall be drilled and located symmetrically off the centre line. The bolt holes shall be concentric with the bore and bolt holes equally spaced. The flanges shall be integrally cast with the pipes and fittings and the two flanges of the pipe shall be correctly aligned.

Materials

The materials used in the manufacture of pipes and fittings shall comply with requirements specified in IS 8329 and IS 9523.

Dimensions and Tolerances

The internal diameter, thickness and length of barrel, dimensions of pipes and fittings shall be as per relevant tables of IS 8329/IS 9523 for different class of pipes and fittings. Each pipe shall be of uniform thickness throughout its length.

The tolerances for pipes and fittings regarding dimensions, mass, ovality and deviations from straight line in case of pipes shall be as per IS 8329/ IS 9523.

Testing

Mechanical Tests

Mechanical tests shall be carried out during manufacture of pipes and fittings as specified in IS 8329 / IS 9523. The frequency and sampling of tests for each batch of pipes shall be in accordance with IS 8329. The test results so obtained for all the pipes and fittings of different sizes shall be submitted to the Contractor or his authorized representative. The method for tensile tests and the minimum tensile strength requirement for pipes and fittings shall be as per IS 8329/IS 9523.

Brinell Hardness Test

For checking the Brinell hardness, the test shall be carried out on the test ring or bars cut from the pipes used for the ring test and tensile test in accordance with IS 1500. The test shall comply with the requirements specified in IS 1500/IS 8329.

(a) Retests

If any test piece representing a lot fails in the first instance, two additional tests shall be made on test pieces selected from two other pipes from the same lot. If both the test results satisfy the specified requirements, the lot shall be accepted. Should either of these additional test pieces fail to pass the test, the lot shall be liable for rejection.

(b) Hydrostatic Test

For hydrostatic test at works, the pipes and fittings shall be kept under test pressure as specified in IS 8329 / IS 9523 for a period of minimum 15 seconds, during which the pipes shall be struck moderately with a 700 g hammer for conformation of satisfactory sound. They shall withstand the pressure test without showing any leakage, sweating or other defect of any kind. The hydrostatic test shall be conducted before surface coating and lining.

Joints

Jointing of DI pipes and fittings shall be done as per IS 12288 and manufacturer's recommendations. After jointing, extraneous material, if any, shall be removed from the inside of the pipe. Rubber sealing rings/gaskets used for jointing shall conform to IS 638, IS 12820 and IS 5382.

Spigot and Socket joints

These shall have sockets which are integral with the pipe and incorporate an elastomeric rubber ring gasket conforming to IS 12820.In particular that the spigot end of the pipe shall be ensured to be jointed is smooth and has been properly chamfered, so that the rubber ring as per IS 12820 and IS 5382 is correctly positioned in line, before the joint is made. The rubber rings and any recommended lubricant shall be obtained only through the pipe supplier.

Gaskets for Flanges

All gaskets used between flanges of pipes shall be of Styrene Butadyne Rubber or EPDM thickness 3 mm suitable for clear water conveyance and as specified by manufacturer.

Flanged joints

These shall be of PN 16 rating and shall comply with dimensions and drilling details as specified in IS 8329. These shall have isolation gaskets between the flanges, isolation sleeves around all bolts and isolation washers under all bolt heads and nuts. All material shall be supplied by a reputed manufacturer. Each bolt should be tightened a little at a time taking care to tighten diametrically opposite bolts alternatively.

Coatings

(a) General

Unless otherwise specified, DI pipes and fittings shall be coated with Bitumen in accordance with relevant IS specification. All buried DI pipes and fittings shall also have factory or site applied polythene sleeving. Coating shall not be applied to pipe and fittings unless its surface is clean, dry and free from rust. Pipe coatings shall be inspected at site and any damage or defective areas shall be made good.

(b) Coating

Bitumen coating shall be of normal thickness of 75 microns unless otherwise specified. It shall be cold applied compound complying with the requirements of relevant Indian standards, suitable for tropical climates, factory applied in accordance with the manufacturer's instructions.

The outer surface of the pipe shall have Zinc coating with finishing layer of Bitumen over it as per IS 8329.

Damaged areas of coating shall be repainted on site after removing any remaining loose coating and wire brushing any rusted areas of pipe.

(c) Cement mortar lining

All pipes and fittings shall be internally lined with cement mortar in accordance with IS: 8329. Cement mortar lining shall be applied at the factory in conformance with the above mentioned standards. Pipe linings shall be inspected on site and any damage or defective areas shall be made good. Lining shall be uniform in thickness all along the pipe. The minimum thickness of factory applied cement mortar lining shall be 3mm for up to DN 300 mm pipes.

(d) Marking

Marking shall be done as per IS 8329 and IS 9523 or any other relevant IS codes.

13.5.48 STERILIZATION OF INSTALLATION

The water supply installation shall be sterilized as per standards and as follows :-

a) Tanks and pipes shall be filled and flushed out.

b) All bib cocks (taps) shall be closed.

c) Tanks and pipes shall be re-filled while adding a sterilizing admixture containing 50 parts chlorine to one million parts water.

d) When the installation is filled all bib cocks (taps) shall be opened progressively and each allowed to run until the water smells of chlorine.

e) The installation shall be topped up and more sterilizer added.

f) The installation shall then be left for three hours and shall then be tested for residual chlorine, if none is found, the installation shall be drained and the process repeated.

g) The installation shall be finally drained and flushed with potable water before use.

13.5.49 EXTERNAL SEWERAGE & STORM WATER DRAINAGE

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

i. Sewerage/Storm water drainage system including, earth works for excavation, disposal, backfilling and compaction, pipe lines, manholes, catch basins and connections to Rain water Harvesting or connected as indicated by the Architect/Consultants.

ii. Overflow from Rain Water Harvesting Pit shall be discharged to existing Storm Water drain either by gravity or by submersible drainage pump.

a) General Requirements:

I. All material shall be of the best quality conforming to specification and subject to the approval of the Engineer-in-charge.

II. Storm Water Drainage lines and open drains shall be laid to the required gradients and profiles.

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

IV. Contractor shall obtain necessary approval and permission for the drainage system from the municipal or any other competent authority if required.

V. Location of all manholes, catch basin etc shall be got confirmed by the Architect/Consultants 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 Architect/Consultants in writing.

b) Excavation :

Alignment and Grade:

The drains are to be laid to alignment and gradients shown on the drawings but subject to such modifications, as shall be ordered by the Construction Manager/Consultants from time to time to meet the requirements of the works. No deviations from the line,

depths of cutting or gradients of sewers shown in the plans and sections shall be permitted except by the express direction in writing of the Construction Manager/Consultants.

Opening out Trenches:

In excavating the trenches at the road metaling, pavement kerbing etc are to be placed on one side and preserved for rein statement when the trench or other excavation shall be filled-up.

Before any road metal is replaced, it shall be carefully shifted. The surface of all trenches and holes shall be restored and maintained to the satisfaction of the Construction Manager/Consultants. The contractor shall not cut or break down any live fence or trees in the line of the proposed works but shall tunnel under them unless the Construction Manager/Consultants shall order to the contrary.

The contractor shall scrub up and clear the surface over the trenches and other excavations of all stumps, roots and all other encumbrances affecting execution of the work and shall remove them from the site to the approval of the Construction Manager/Consultants.

Construction Across the Roads:

All works across the roads shall be carried out as per the directions of the Construction Manager/Consultants.

Excavation to be taken to proper depth:

The trenches shall be excavated to such a depth that the sewers shall rest as described earlier so that the inverts may be at the levels given on the section/plan. If the strata found as slushy/with block cotton soil etc, the Construction Manager/Consultants may order the contractor to excavate to a greater depth than that shown on the drawings and to fill up the excavation to the level of the sewer with such materials as decided by Construction Manager/Consultants in writing.

Refilling:

After the sewer or other works have been laid and proved to be water tight, the trench or other excavation shall be refilled. Utmost care shall be taken in doing this, so that no damage is caused to the sewer and other permanent works. Filling in the trenches upto 50 cms above the crown of the sewer shall consist of the finest selected materials placed carefully in 15 cms layers watered to optimum moisture level and consolidated. After this has been laid, the trench and the other excavation shall be refilled carefully in 15 cms layers with materials taken from the excavation, each layer being watered and consolidated.

Contractor shall restore settlement and damages:

The contractor shall at his own cost make good promptly during the whole period the works are in hand, any settlements that may occur in the surfaces or roads, beams, footpaths, gardens, open spaces etc. Whether public or private caused by his trenches or by his other excavations and he shall be liable for any accidents caused thereby.

He shall also at his own expense and charges, repair and make good any damage done to the building and other properties.

Disposal of Surplus Soil:

The contractor shall at his own cost and charge, dispose off from the site all surplus excavated material not required to be used on the works.

Timbering of Sewer and Trenches:

The contractor shall at all times support efficiently and effectively the sides of the sewer trenches and other excavations by suitable timbering. piling, sheeting, etc in loose or sandy strata and below the surface of the sub soil water table without extra cost.

All timbering, sheeting and piling with their walls and supports shall be of adequate dimensions and strengths and fully broad and strutted so that there is no risk of collapse or carrying in the walls of the trench.

The Contractor shall be held accountable and responsible for the sufficiency of all timbering, bracing, sheeting and piling used, and for all damage to persons and property resulting from the improper quality, strength, planning, maintaining or removing of the same.

WIDTH OF TRENCH :

a) Recommended width of trenches at the bottom shall be as follows or as specified in the CPWD /BIS specification :-

100mm dia pipe	Outer dia of pipe + 45cms
150mm dia pipe	Outer dia of pipe + 45cms
200-250 dia pipe	Outer dia of pipe + 45cms
300mm dia pipe	Outer dia of pipe + 45cms
450mm dia pipe & above	Outer dia of pipe +45cms

c) Recommended width of trench at top shall be as follows or as specified in the CPWD /BIS specification :-

Depth up to 1.5m	- width of Bottom = width of top
Depth from 1.5m to 3m	- Bottom width + (2X500mm)
Depth From 3m to 4.5 m	- Bottom width +(4X500mm)
Depth From 4.5m to 6.0 m	- Bottom width + (6X500mm)

Protection of Existing Services:

All pipes, water mains, cables etc encountered in the course of excavation shall be carefully protected and supported.

13.5.50 Gully traps :

Gully traps shall be of the same quality as described for stoneware pipes under para Salt Glazed Stoneware Pipes.Gully traps shall be fixed in cement concrete 1:4:8 mix and a masonary chamber 300 x 300 mm. The CI sealed cover and frame shall weigh not less than 7.3 kg. Where necessary, sealed cover shall be replaced with CI grating of the same size.

13.5.51 Reinforced Cement Concrete Pipes :

All underground storm water drainage pipe shall be centrifugally spun S & S RCC Pipe of specified class. Pipes shall be true and straight with uniform bore, through out cracked, wrapped pipes shall not be used on the work. All pipes shall be tested by the manufacturer and the Contractor shall produce, when directed a certificate to that effect from the manufacturer.

Laying of R.C.C. Pipes:

Loading, transporting and unloading of concrete pipes shall be done with care. Handling shall be such as to avoid impact. Gradual unloading by inclined planes or by chain block is recommended. All pipe sections and connections shall be inspected carefully before being laid. Broken or defective pipes or connections shall not be used. Pipes shall be lowered into the trenches carefully. Mechanical appliances may be used. Pipes shall be laid true to line and grade as specified. Laying of pipe shall proceed upgrade of a slope.

If the pipes have spigot and socket joints, the socket end shall face upstream, in the case of pipe with joints to be made with loose collars, the collars shall be slipped on before the next pipe is laid. Adequate and proper expansion joints shall be provided where directed.

In cases where the natural foundation is inadequate, the pipes shall be laid either in concrete cradle supported on proper foundation or on any other suitable designed structure as specified. If a concrete cradle bedding is used, the depth of concrete below the bottom of the pipe shall extend up the sides of the pipe at least to distance of 1/4th

of the outside diameter of pipe. The pipe shall be laid in this concrete bedding before the concrete has set.

When the pipe is laid in a trench in rock hard clay, shale or other hard material, the space below the pipe shall be excavated and replaced with an equalizing bed of concrete, sand or compact earth. In no place shall pipe be laid directly on such hard material.

When the pipes are laid completely above the ground, the foundations shall be made even and sufficiently compacted to support the pipe line without any material settlement. Alternatively the pipe line shall be supported on p.c.c. saddle blocks. Similar arrangement shall be made to retain the pipe line in the proper alignment, such as by shaping the top of the supports to fit the lower part of the pipe. The distance between the supports shall in no case exceed the length of the pipe. The pipe shall be supported as far as possible close to the joints. In no case shall the joints come in centre of the span. Care shall be taken to see that superimposed loads greater than the total load equivalent to the weight of the pipe when running full shall not be permitted.

Jointing of Pipes:

Joints are generally of rigid type. Where specified flexible type joints may also be provided.

Spigot and Socket Joint (rigid):

The spigot of each pipe shall be slipped home well into the socket of the pipe previously laid and adjusted in the correct position. The opening of the joint shall be filled with stiff mixture of cement mortar in the proportion of 1:2 (1 cement :2 fine sand) which shall be rammed with caulking tool.

After a day's work any extraneous material shall be removed from the inside of the pipe and the newly made joint shall be cured.

Collar Joint (rigid):

The two adjoining pipes shall be butted against each other and adjusted in corrected position. The collar shall then be slipped over the joint, covering equally both the pipes. The annular space shall be filled with stiff mixture of cement mortar 1:2 (1 cement :2 fine sand) which shall be rammed with caulking tool.After a day's work any extraneous material shall be removed from the inside of the pipe and the newly made joint shall be cured.

The Testing of Joints, Refilling of Trenches:

The testing of joints, refilling of trenches for concrete pipes shall be similar to Specification for stone ware pipes.

13.5.52 **Cement Concrete for Pipe Support :**

a) Wherever specified or shown on the drawings, all pipes shall be supported on a bed, all around or in haunches. The thickness and mix of the concrete shall be as given in the Schedule of Quantities. Width of the bedding shall be under para Width of Trenches.

	Upto 1.5 m Depth	**Upto 3 m Depth**	**Beyond 3 m Depth**
Stoneware Pipes I pipe in open ground (no sub soil water)	All round (1:5:10)	In haunches (1:5:10)	In haunches (1:5:10)
RCC or SW in sub soil water	All round (1:5:10)	In haunches (1:5:10)	In haunches (1:5:10)
CI Pipes (in all conditions)	All round (1:3:6)	In haunches (1:3:6)	In haunches (1:3:6)
RCC Pipes or CI pipes under building	All round (1:3:6)	In haunches (1:3:6)	In haunches (1:3:6)

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

13.5.53 Manholes and Chambers :

All manholes, chambers and other such works as specified shall be Constructed in brick masonry in cement mortar 1:5 (1 cement: 5 coarse sand) or as specified in the Schedule of Quantities.

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

All manholes shall be provided with cement concrete benching in 1:2:4 .

Nominal mix (1 cement: 2 coarse sand: 4 stone aggregate 20mm nominal size). The benching shall have slope of 1:10 towards the channel. The depth of the channel shall be full diameter of the pipe. Benching shall be finished with a floating coat of neat cement.

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

All manholes with depths greater than 1m shall be provided with 20 mm square or 25 mm round CI foot rests set in cement concrete blocks 250x100 mm in 1:2:4 mix (1 cement: 2 coarse sand: 4 stone aggregate 20 mm nominal size), at 300 mm centre to centre vertically and staggered. Foot rests shall be coated with coal tar before embedding.

All manholes shall be provided with cast iron covers and frames and embedded in reinforced cement concrete slab. Weight of cover, frame and thickness of slab shall be as per standard.

13.5.54 Testing:

All testing shall be done in accordance with IS:1172 and IS:5329 except as may be modified herein under.

All lengths of the sewer/drain/pipelines shall be fully tested for water tightness by means of water pressure. Testing shall be carried out from manhole to manhole. All pipes shall be subjected to a test pressure of at least 2.5m head of water. The test pressure shall, however, not exceed 6m head at any point. The pipes shall be plugged preferably with upper end shall, however, be connected to a pipe for filling with water and getting the required head. The sewer/drain/pipeline shall be filled with water and left to stand for 2 hours and topped up. The leakage over 30 minutes shall then be measure and the loss in water shall not exceed 2 litres/cm of diameter/km of pipeline measured during the last 10 minutes of the period of test.

Sewer lines shall be tested for straightness by:

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

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

The pipeline shall be covered only after the testing is successfully completed

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

a) Requirement of adequate and equal pressure availability of hot and cold water lines in Toilets and other identified areas.

b) Adequate storage of water in underground raw + overhead treated domestic / Raw water tanks.

c) Provision of firefighting appurtenance such as fire hydrants, hose reel, sprinklers and portable extinguishers.

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

e) Landscape layout.

f) Storm / Rain water drainage system from various levels of the building and disposal to Rain Water Harvesting System / storm water drain.

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

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.

14.0 **SAMPLES OF MATERIALS**

14.1 The contractor shall submit to the Engineer-in-Charge samples of all materials as per specifications to be used in the work for approval before bringing bulk supplies and before commencing the work. These approved samples shall be preserved and retained in the custody of the Engineer-in-Charge as standard of materials till the completion of the work. The cost of such samples shall be borne by the contractor and nothing shall be payable on this account.

14.2 Sub-standard Material/ Work: In case any material/ work is found sub-standard the same shall be rejected by the Engineer-in-Charge and the same shall be removed from the site of work .

14.3 Testing of Materials: Even ISI marked materials may be subjected to quality test at the discretion of the Engineer-in-Charge besides testing of other materials as per the specifications described for the item/ material. Whenever ISI marked materials are brought to the site of work the contractor shall, if required by the Engineer-in-Charge, furnish manufacturer test certificate or test certificate from approved testing laboratory to establish that the material procured by the contractor for incorporation in the work satisfy the provisions of IS Codes relevant to the material and/ or the work done.

14.4 The contractor shall arrange carrying out of all tests required through the laboratory as approved by the Engineer-in-Charge. The cost of tests shall be borne by the contractor. In addition contractor shall establish a laboratory at site of work at his own cost. The laboratory shall be equipped with all necessary equipment as per requirement of specification or as per direction of Engineer-in-Charge. Establishing the laboratory at site shall not absolve the contractor from fulfilling the criteria of getting the test done in independent Lab. The decision of the Engineer-in-Charge of allowing any test in the site laboratory or any other laboratory shall be final.

14.5 Before execution of finishing items like plaster, flooring & painting etc, the contractor shall make samples for finishing items and get the approval well in advance from the Engineer-in-
Charge.

15.0 LIST OF APPROVED MANUFACTURERS/ MAKES

List of Makes of materials approved by the Engineer-in-Charge are listed below (Refer materials whichever are applicable for the scope of work). However, approved equivalent materials of any other specialized firms may be used, in case it is established that the brands specified below are not available in the market subject to approval of the alternate brand by the Engineer-in-Charge.

Sl. No.	Item/Material	Manufacturer/ Supplier/ Make
1.0 CIVIL , STRUCTUAL & ARCHITECTURAL ITEMS		
1.1	Cement	ACC, Sri Cement, JK Cement, Gujrat Ambuja Cement, Ultratech Cement, Lafarge India cement.
1.2	White Cement	JK Cement, Birla White
1.3	Reinforcement Steel	SAIL, TATA Steel, RINL.
1.4	Structural Steel	SAIL, TATA Steel, RINL.
1.5	Admixture for Concrete	FOSROC, SIKA, CICO, BASF
1.6	Aluminium Sections	HINDALCO, JINDAL, MAHABIR, INDAL
1.7	Ready Mixed Concrete (RMC)	ACC, L&T, AHLCON, JK CEMENT, UNITECH, GRASIM
1.8	Insulation	UP TWIGA, LLOYD INSULATION INDIA LTD, SUPREME
1.9	Ceramic Tiles	1st QUALITY OF KAJARIA, JOHNSON, NITCO,

		SOMANY
1.10	Vitrified Tiles	1st QUALITY OF KAJARIA, JOHNSON, NITCO, SOMANY
1.11	Wooden Flooring	ARMSTRONG, NEMO, PRIMA, PERGO
1.12	Anodized Aluminium Fittings for Doors/ Windows	CROWN, ALANS, CLASSICS, BHARAT, ARGENT
1.13	Mosaic & P.C. Tiles	NITCO, MRIDUL, MODERN
1.14	Waterproofing compound	FOSROC, CICO, PIDILITE
1.15	Waterproofing Membrane	FIRESTONE, CARLISLE, STP
1.16	Stainless Steel Section/ Sheet	JINDAL, SAIL, GOLDEN, SALEM STEEL
1.17	False Ceiling (Gypsum Board)	SAINT GOBAIN, LAFARGE, ARMSTRONG
1.18	False Ceiling (Mineral Fibre)	LLOYD, NITTBO, ARMSTRONG, ROCKFON
1.19	Kerb stones/ Interlocking Paver Blocks/ Chequered Tiles/ Saucer Drain	HINDUSTAN TILES, NIMCO PREFAB, K.K, NITCO
1.20	Distemper and Paints	1st QUALITY OF ASIAN, BERGER, NEROLAC
1.21	Texture Finish	ASIAN, BERGER, NEROLAC
1.22	Waterproof Cement Paint	SNOWCEM, ASIAN PAINT, BERGER
1.23	Steel and wood primer	NEROLAC, BERGER, ASIAN PAINTS
1.24	Enamel painting on pipes	ASIAN, BERGER, JENSON & NICHOLSON
1.25	Silicon Sealant	DOW CORNING, WACKER, GE
1.28	Cement Wall Putty	JK, BIRLA
1.29	Welding Electrodes	ESAB, ADVANI
1.30	Flush Doors shutters	JYOTIPLY, MERINO, GREEN PLY, CENTURY PLY, ARCHID
1.31	Laminate Sheet	MERINO, GREEN PLY, ARCHID, CENTURY PLY
1.32	Pre-laminated particle board	NOVOPAN, MERINO, ANCHORLAM, BHUTAN BOARD, ARCHID PLY
1.33	Wood Veneer	GREENLAM, MERINO , CENTURY
1.34	M.S. Butt Hinges/ Piano Hinges	JOLLY, GARG, ASI SUPREME
1.35	Fire rated doors	NAVAIR, SUKRI, SUPER STEEL, RADIANT, GODREJ
1.36	Panic Bars	BRITON, DORMA, DORSET, GODREJ
1.37	Locks/ Latches	DORSET, DORMA, GODREJ
1.38	Door Handles	DORSET, OZONE, GODREJ
1.39	Hydraulic door Closer/ floor spring	DORSET, OZONE, GODREJ
1.40	Misc. door fittings (Tower Bolts, Stopper etc.)	DORSET, HAFELE, GODREJ, OZONE, JOLLY
1.41	Adhesive & grouts	KERAKOLL, BAL ENDURA, FOSROC, PIDILITE
1.42	Glass	SAINT GOBAIN, MODI FLOAT, ASAHI
1.43	Brick-coba waterproofing and acrylic impregnation treatment	OVERSEAS W.P.CO, ROOFRS COMBINE, DEVICON INTERNAZIONALE, HINDUSTAN WATERPROOFING
1.44	Mirror	SAINT GOBAIN, MODI FLOAT, ASAHI
1.45	Polycarbonate Sheet	DANPALON, SUNPAL, POLYGAL
1.46	Bitumen impregnated board	SHALIMAR, ARMOUR

1.47	Block Board/ Ply	PHENOL BONDED BOARDS OF JYOTIPLY, MERINO, ARCHID PLY
1.48	Frosted Film	LIUMAR, 3M, AVERY, IQUE
1.49	Expansion Hold Fastener	HILTI, CANON, CHILLI
1.50	Anchor Fasteners/ Dash Fasteners	HILTI, FISCHER, CANON
1.51	Friction stay hinges	EBCO, JOLLYGARD, AMIT, ASI SUPREME
1.52	SS Cramps	HILTI, CANON, FISCHER
1.53	Nuts, bolts and screws	KUNDAN, PUJA, ATUL
1.54	Tile adhesive	CICO, PIDILITE, BAL, LATECRETE
1.55	Floor Hardener	AKZO NOBEL, SIKA
1.56	PVC Water Stop Seal	MARUTI RUBBER UDYOG, JYOTI, FOSROC, FIXOPAN, SYNTEX
1.57	Gypsum Partitions	SAINT GOBIAN, LAFARGE
1.58	Grab Bars	MERINO,HAFELE, JAQUAR, HINDWARE
2.0	**PLUMBING AND SANITARY ITEMS**	
2.1	Sanitary ware fixtures	HINDWARE, PARRYWARE, CERA
2.2	Seat Covers	COMMANDER (HEAVY DUTY), HINDWARE, PARRYWARE, CERA
2.3	C.P. Fittings	GEM, PARKO, JAQUAR, KINGSTON, MARC
2.4	Stainless steel sinks	JAYNA, NEELKANTH, AMC
2.5	Automatic Flushing for Urinals	ANGASH INTERNATIONAL, KOPAL
2.6	PVC Storage Tank & Doors for Toilets	SINTEX, UNIPLAS, DURAPLAST
2.7	G.I. Pipe	TATA, JINDAL, SURYA, PRAKASH
2.8	G.I. Fittings	UNIK, R BRAND, KS, ZOLOTO-M
2.9	Ball valves	ZOLOTO, AM, LEADER
2.10	Butterfly valves	AUDCO, INTERVALVE, KEYSTONE, VENUS, KSB
2.11	Non-return Valves	LEAER, ZOLOTO, KIRLOSKAR, VC
2.12	Balancing Valves	DANFOSS, FLOWCAN, TA, BELIMO, OVENTROP
2.13	C.I. Pipes/ Fittings & Manhole Covers	RIF, NECO, SRIF, BIC
2.14	C.I. Pipes 'Class LA'	IISCO, KESORAM, ELECTRO STEEL
2.15	Stoneware Pipes/ Traps	PERFECT, BURN, ANAND
2.16	UPVC Pipes/ Fittings	SUPREME, FINOLEX, POLYPACK, PRINCE, SFMC
2.17	Flush Valve	GEM, JAQUAR, ORIENT
2.18	M.S. Pipes	TATA, JINDAL
2.19	R.C.C. Pipes	I.H.P., AKSHAY, KK, PRAGATI
2.20	Anti-vibration Mountings/ Vibration Eliminators	KANWAL, DUNLOP, RESISTROFLEX
2.21	Gate Valves	LEADER, DRP, SANT, ZOLOTO,TBS, RB, DANFOS
2.22	Float Valves	LEADER, ZOLOTO, SANT

2.23	SRFC/ RCC Manhole, Covers & Gratings	K.K. MANHOLES, MOONLITE, S.K. PRECAST CONCRETE, PRAGATI CONCRETE
2.24	Anti-corrosive Pipe Treatment	IWL - PYPKOAT, RUSTECH-COATEK, MAKPOLYCOAT
2.25	G.I. Hangers for Pipes/ Adjustable Hanger	CHILLY, EURO CLAMP, KANWAL
2.26	DWC/ HDPE Pipes	DURALINE, ORIPLAST, HALLMARK, PIUNEER
2.27	Drainage pumps	GRUNDFOS, KSB, DP, EBARA, WILO
2.28	PVC Pipes and fittings	SUPREME, FINOLEX,POLYPACK, PRINCE
2.29	Cockroach Trap	CHILLY (CCT), NEER, CAMRY
2.30	Standard M.S. fittings	UNIK, TRUE FORGE, R BRAND
2.31	Forged steel fittings	VS ENGINEERING, TRUE FORGE, B&M
2.32	Temper switch	SYSTEM SENSOR, SWITZER, DANFOSS
3.0	**ELECTRICAL ITEMS**	
3.1	L.T. Panel/ Bus Duct/ DG Panel/ APFC Panel/ PLC Panel	TRICOLITE, CONTROL AND SWITCHGEAR VEEKAY STEEL, ADLEC SYSTEMS, L&T, ADVANCE
3.2	Moulded Case Circuit Breaker	L&T (D-SINE), SIEMENS (3VT), GE POWER (RECORD PLUS), ABB (ISOMAX), LEGRAND (DPX3)
3.3	MCB	L&T, HAGER, LEGRAND, SIEMENS
3.4	Relay	L&T, ABB, AREVA, SCHNEIDER, SIEMENS, C&S
3.5	Contactors	L&T, ABB, HAGER, SIEMENS
3.6	Meters, CT etc.	KAPPA, C&S, L&T, MAXWELL, GILBERT
3.7	Starters	SIEMENS, L&T, CUTLER HAMMER
3.8	Push button and indication lamps	SIEMENS, VAISHNOV, L&T, SCHNEIDER
3.9	Voltmeter/ Ammeter	MECO, UNIVERSAL, RISHAB, AE, HAGER
3.10	Digital meters and Intelligent Multifunction Meter	CONZERVE, HPL, TRINITY, L&T, SIEMENS
3.11	Timers & Time Switch	L&T, SIEMENS, ABB, LEGRAND, SCHNEIDER
3.12	Selector Switch/ Push Button Switch/ Emergency Switch	KAY CEE, L&T, SALZER
3.13	Fuse Disconnector Switch/ Switch Fuse Units	L&T, SIEMENS, GE POWER
3.14	HRC Control Fuses	L&T, SIEMENS, GE POWER
3.15	PLC	ABB, SIEMENS, SCHNEIDER, L&T
3.16	Cable tray	SLOTCO, PILCO, STEEL WAYS, RICCO STEEL
3.17	Raceway	LEGRAND, MK, L&T
3.18	Transformer	ABB, KIRLOSKAR, CROMPTON GREAVES, UNIVERSAL
3.19	Air Circuit Breaker	L&T (UPOWER OMEGA MTX4.5), ABB (EMAX PR123), LEGRAND (DMX3 MP4), SCHNEIDER (MASTERPACT NW-7.0A)
3.20	Flow Switch	SYSTEM SENSOR, SWITZER, DANFOSS
3.21	Change Over Switch	H.P.L. SOCOMEC, L&T, C&S
3.22	Pressure Gauge	H GURU, FIEBIG, EMERALD
3.23	Single Phasing Preventer/ Overload Protection Unit	OMERON, SHNEIDER, L&T-MNX, ABB-A RANGE, SIEMENS
3.24	Pressure Switch	SYSTEM SENSOR, INDFOS

3.25	Water Level Controllers & Indicators	AUTO PUMP, MINILEC, DANFOSS, TECHTROL
3.26	PVC conduit & accessories (ISI marked)	BEC, AKG, M KAY
3.27	M.S. conduit & accessories (ISI marked)	BEC, AKG, NIC, M KAY, STEEL CRAFT
3.28	PVC insulated copper cable (ISI marked)	SKYTONE, GRANDLAY, FINOLEX, KEI, HAVELS, BATRA HENLAY
3.29	FRLS PVC insulated copper conductor cable (ISI marked)	SKYTONE, FINOLEX, NATIONAL, RR CABLE, KEI, PLAZA, HAVELS
3.30	Telephone Tag Block	KRONE, IS, ERICSSON
3.32	Modular plate type switches & sockets, TV Outlet, Fan Regulators, Telephone Outlet	ANCHOR-ROMA, MK, LEGRAND, CRABTREE NORTHWEST, PHILIPS
3.33	Industrial sockets	LEGRAND, ABB, SCHNEIDER, L&T, SIEMENS, HAVELS
3.34	ELCB/ RCCB (ISI marked)	HAGER, SIEMENS, LEGRAND, SCHNEIDER, L&T, GE, HENSELS
3.35	Earthing Wire	JINDAL, T.T. SWASTIK, SURYA
3.36	Distribution Boards	LEGRAND, HAGER, L&T, GE, SEIMENS, HENSELS
3.37	Cable glands (single/double compression)	COMMET, DOWELL, ELETROMAC, SEIMENS, BRACO, INDIANA
3.38	Termination Kits	RAYCHEM, 3M, M SEAL
3.39	Lugs/ Ferrules & Thimbles	DOWELLS, JAINSONS, ELETROMAC, SEIMENS,
		BRACO, INDIANA
3.40	Sensor (Light & Occupancy)	PHILIPS, L&T, LEGRAND, WIPRO, SCHNEIDER
3.41	Rubber/ Synthetic Insulating	DL MILLER & CO, SINTEX (INSULATICA) PREMIER
	mats	POLYFILM, RMG POLYVINYL INDIA
3.42	UPS	EATON, MITSUBISHI, APC, RIELLO
3.43	Batteries	EXIDE, AMCO, PRESTOLITE, AMARON STANDARD FURUKAWA
3.44	XLPE Insulated H.T. Cables (ISI Marked)	GLOSTER, SKYTONE, TORRENT, HAVELS, RAVIN, KEI, CCI, UNIVERSAL, RPG (ASIAN), BATRA HENLAY
3.45	L.T. Power Cables & Control Cables (ISI Marked)	CCI, GLOSTER ,NICCO, UNIVERSAL, RPG (ASIAN), SKYTONE, KEI, RAVIN, HAVELS, BATRA HENLAY
3.46	Exhaust fans	CROMPTON, BAJAJ, USHA, GEC
3.47	Ceiling Fans	CROMPTON, BAJAJ, USHA, GEC, ORIENT, THE HEAVEN INDIA
3.48	Internal light fixtures (CFL, LED etc.)	PHILIPS, BAJAJ, WIPRO, CROMPTON, LIGHTING TECHNOLOGIES, PANASONIC
3.49	Aviation Warning Light	WIPRO, GEC, BAJAJ
3.50	LED indicating Lamps & Push Buttons	SIEMENS, VAISHNOV, L&T
3.51	Street light Poles and Fixtures	PHILIPS, BAJAJ, WIPRO, CROMPTON, HAVELLS
3.52	Fire Alarm & Detection System	SIEMENS, CEASEFIRE, HOCHIKI, HONEYWELL NOTIFIER, SCHRACK, COOPER
FIRE	**FIGHTING WORKS**	
4.1	Fire Hydrant Valve/ Landing Valve	MINIMAX, GUARDS, NEWAGE, SAFEX
4.2	Fire Hose Flexible Pipe (R.R.L.)	JYOTI, MINIMAX, TIGER, MARUTI
4.3	Coupling/ Branch Pipe & Nozzle	MINIMAX, GUARDS, NEWAGE, PADMINI, SAFEX

4.4	Fire Water Pumps	KIRLOSKAR, CROMPTON GREAVES, MATHER & PLATT, KSB, GRUNDFOS
4.5	Electric Motor	ABB, SIEMENS, KIRLOSKAR, CROMPTON GREAVES
4.6	Fire Hose Cabinet	MINIMAX, PADMINI, SAFEX
4.7	Fireman Axe	NEWAGE, GUARDS, MINIMAX, SAFEX
4.8	Fire Hose Reel	NEWAGE, GUARDS, MINIMAX, SAFEX
4.9	Fire Extinguishers	NEWAGE, GUARDS, MINIMAX, SAFEX
4.10	Strainers	EMARALD, WJ, SRAINWEL, SANT
4.11	Sluice Valve	LEADER, KIRLOSKAR, ZOLOTO
4.12	Mechanical Seal	SEALOL, BURGMAN, DURAMAT
4.13	Dual Plate Check Valve	ADVANCE, KIRLOSKAR, AUDCO, ECONOSTO
4.14	Installation Control Valve	TYCO, VIKING, HD
4.15	Underground Pipe Protection Wrapping	IWL-PYPKOTE, RUSTECH-COATEK
4.16	Sprinkler Head/ Unbraided Flexible Sprinkler Pipe	TYCO, VIKING, NEWAGE, SAFE FIRE
CCTV WORKS		
5.1	CCTV Camera (along with mounting etc.)	VICON, PELCO, SIEMENS, HONEYWELL, BOSCH, AXIS, DVTEL, SONY
5.2	Network video management and recording Software	VICON, PELCO, SIEMENS, HONEYWELL, BOSCH, AXIS, DVTEL, SONY
5.3	Network video recorder/ video management Server	IBM-E SERVERS, DELL-POWER EDGE, HP-DL360-DL380, BOSCH, NICE, HONEYWELL, SONY, DVTEL, PELCO, SIEMENS
5.4	Network Attached Storage	DELL, IBM, HP ,EMC , HITACHI , BOSCH , PELCO
5.5	Client PC	DELL, IBM, HP
5.6	Network Switches	CISCO , HP , JUNIPER
5.7	LCD/TFT monitors	SAMSUNG, PANASONIC, SONY, LG , BOSCH , PELCO
5.8	Printer	HP, SHARP, CANON
5.9	UTP Cables	DIGILINK, SYSTIMAX, MOLEX, TELIFLEX, POLYCAB, UNIFLEX, BELDEN, HEW, KRAPEN, LEONI, COMMSCOPE
5.10	Batteries for CCTV System	ROCKET, QUANTA, PANASONIC, AMCO, HBL
5.11	Power Supply Unit	PELCO, SIEMENS, HONEYWELL, BOSCH, AXIS, SONY
HVAC WORKS		
6.1	Supply/ Return Air Grill	AIRMASTER, RUSKINTITUS, SYSTEMAIR, AIR FLOW
6.2	Water Cooled Chillers	CARRIER, TRANE, YORK, DAIKIN
6.3	Condenser Water Pump	ITT, GRUNDFOS, ARMSTRONG, WILO, KIRLOSKAR
6.4	Primary Chilled Water Pump	ITT, GRUNDFOS, ARMSTRONG, WILO, KIRLOSKAR
6.5	Secondary Chilled Water Pump	ITT, GRUNDFOS, ARMSTRONG, WILO
6.6	Cooling Tower	PAHARPUR, MIHIR, ADVANCE, MARLEY, BELL
6.7	AHUs with Cooling coils	BLUE STAR, VOLTAS, ETA, CARRIER, TRANE, ZECO, EDGETECH, WAVES, CARRYAIR, FEDDERS LLOYD, SUVIDHA-SAIVER

6.8	VFD	DANFOSS, SIEMENS, ABB, ALLEN BRADLEY
6.9	Fan coil units	BLUESTAR, VOLTAS, DAIKIN, CARRIER, ETA, ZECO, WAVES, HI TECH
6.10	Centrifugal fans	KRUGER, NICOTRA, COMEFRI, GREENHECK
6.11	Tube Axial fans	KRUGER, NOCOTRA, COMEFREE, FLAKWOOD, WOLTER, GREENHECK, NUAIRE, SYSTEMAIR
6.12	Propeller fan	ALSTHOM, CROMPTON, GE, OSTBREG, KRUGER, NUAIRE
6.13	In Line fan	KONAFLAKT, KRUGER, OSTBERGG, ALSTOM, NUAIRE
6.14	Grill/ Diffuser/ Dampers	CARRYAIR, RAVISTAR, AIRMASTER, DYNA CRAFT, FEDDERS LLOYD
6.15	Fire Dampers	RAVISTAR, DYNA CRAFT, CARRYAIR, AIRMASTER, CONAIR
6.16	G.I. Sheets	JINDAL, SAIL, TATA, ESSAR
6.17	Factory fabricated duct	ZECO, TECHNO, ROLASTAR, VOLTAS, ALPHA DUCT, DUCTOFAB
6.18	Hessian (fire treated)	NAVAIR, PYROGUARD
6.19	Pre-insulated chilled water pipe	ZECO, SEVEN STAR
6.20	Thermometer	TAYLOR, H GURU, FIEBIG, EMERALD, ANERGY
6.21	Air Washer	AIR FLOW, BRIGHT FLOW, AMBASSADOR, ROOTS
6.22	Air Washer Fan	KRUGER, NICOTRA, COMFERI
6.23	Air Washer Pump	KIRLOSKAR, BEACON, CROMPTON
6.24	Air Scrubber	AIR FLOW, BRIGHT FLOW, AMBASSADOR, ROOTS
6.25	Suction Guide	ANERGY, EMERALD
6.26	2/3 way modulating valve for AHU	HONEYWELL, SIEMENS, DANFOSS, BELIMO, JOHNSON CONTROL, SCHNEIDER
6.27	Room thermostat/ humidistat & Safety thermostat	HONEYWELL, SIEMENS, DANFOSS, BELIMO, JOHNSON CONTROL, SCHNEIDER
6.28	Dial thermometer (capillary Type)	PENN, H GURU, FEIBIG, EMERALD, TADINGTON
6.29	Cooling/ Heating Mode changer	SIEMENS, HONEYWELL
6.30	Pre-moulded PUF section for insulation	LLYOD, MALANPUR, BEARDSEL, SUPREME
6.31	Nitrite Insulation	ARMACEL, VIDOFLEX, SUPREME, K-FLEX, LLYOD INSULATION
6.32	PUF pipe supports	MALANPUR, LLOYD, BEARDSEL
6.33	Aluminium tape	JOHNSON, BIRLA, 3M
6.34	Expansion tank (pressurized) and Air Separator	ITT, WESSELS, GRUNFOSS, ANERGY, ARMSTRONG
6.35	Heat Recovery Wheels	DESICCANT ROTORS INTERNATIONAL (DRI), NOVELAIR TECHNOLOGY, EVENTUS (OSTERBERG), FLAKWOOD, BRYAIR
6.36	Filters (in Air-Conditioning System)	THERMODYNE, PUROLATOR, ANFILCO
6.37	Temperature Sensor	SONTAY, KELE, MAMAC
6.38	Ultra violet germicidal Irradiation system	RUKS, TRIMED, OMNISCENT TREATMENT TECH
6.39	Precision AC units	EMERSON, BLUE BOX, STULZ
6.40	Aluminium sheets	HINDALCO, BALCO, NALCO
6.41	Closed cell fire retardant XLPE	PARAMOUT, ARMACELL, AEROFLUX, TROCELLEN, EUROBATAX, SUPREME, PILON-THERMOSHIELD

6.42	Expanded polystyrene	METTURBEARDSELL, STRYNE PACKING, SUPREME, COCOLITE, DEBS PRODUCTS, INDIAN PACKAGING, TOSHIBA
6.43	Fibre glass rigid Board	UP TWIGA, OWEN CORNING, KIMCO, LLYOD INSULATION
6.44	Tarfelt/ CPRX compound	SHALIMAR, ASIAN
6.45	Copper refrigerant piping	DIAMOND, STAR, RAJCO
ELEVATORS		
7.1	Elevators	KONE, THYSSENKRUPP, MITSUBISHI,OTIS
SOLAR PV SYSTEM		
8.1	Solar PV System	MOSERBAER, PHOTON, TATA BP, EMVEE, BHEL, CEL, GEO POWER

FIRE FIGHTING

16.0 FIRE FIGHTING WORKS

16.1 GENERAL

SCOPE OF WORK

The scope of work under the sub head 'Fire Fighting Works' includes the following:

a) Installation of External and Internal Hydrant System and First Aid Hose Reels.
b) Installation of Automatic Sprinkler System
c) Installation of Fire Fighting Pumping system and associated pipe work
d) Obtaining approvals and NOC from local fire bodies.

The specifications for the supply, installation, testing and commissioning of the components and accessories of the Fire Fighting System, shall be in accordance with these Specifica-tions. For items not included in these Specifications and the Special conditions installation shall be done in accordance with the latest IS Standard/ NFPA codes.

For items not covered by any of the above the installation shall be done as directed by the Construction Manager and as per sound engineering practices.

16.2 STATUTORY APPROVALS

Fire Fighting Installation shall be in conformity with the regulations of local Fire Department and TAC.

The Contractor shall be responsible for obtaining the approval of the Local Fire Department for the installation done under the scope of work. The work will not be considered as complete unless the N.O.C/clearance certificate from Chief Fire Officer is provided.

16.3 TECHNICAL SPECIFICATION

The work shall be carried out as per the enclosed Specifications of Work and the construction drawings to be issued from time to time. These specifications shall be read in conjunction with CPWD specifications 2002 (with up-to-date correction slips), National Building Code 2005, relevant Codes of Practice and Standards as issued by Bureau of Indian Standards (B.I.S. - all with the latest amendments) wherever applicable, Fire Protection Manual & Sprinkler Regulations of Tariff Advisory Committee (TAC) & NFPA (USA) Publications.

16.4 DRAWINGS AND DOCUMENTS

16.4.1 General

a) The Drawings provided with the Specification shall be treated as confidential documents and must not be copied or loaned to any other party without the express permission of the Engineer-in-Charge.

b) The Drawings are intended as a guide to the firms tendering and give approximate positions of pipes, conduits, cable runs and/or equipment only and in measuring from these drawings, the Bidder must make due and proper allowance for all necessary diversions from the straight line, rises or falls as may be required for the proper execution of the works. Detail drawings in all cases shall be worked to in preference to those of a more general nature and figured dimensions where indicated shall be followed in preference to scale. Where necessary, the exact positions of plant and/or equipment will be decided by the issue of further drawings, but no claim for extra payment due to insufficient information on this scope will be entertained. In any case of doubt as to the interpretation of either Drawings and/or Specification, the Contractor must refer the matter to the Engineer-in-Charge prior to the submission of his Tender.

c) It is to be clearly understood that this Tender is to be absolutely inclusive for the proper completion of the whole of the works specified to the true intent and meaning of the specification and/or Drawings and the description therein contained shall be read

conjointly and together and no error, inconsistency, discrepancy in the Drawings and/or Specification will relieve the Contractor of his obligations to include for an hand-over the work in the true meaning and intent of the Specification and/or Drawings, complete in every respect. Should any portion of the works which would reasonably and obviously be inferred as necessary for the installation as a whole not be expressly specified, the Contractor shall provide and execute such work as part of the Contract and shall not be entitled to any extra payment of that account.

d) The Contract Drawings and such other drawings as may be furnished to the Contractor during the progress of the Works shall be considered as illustrating between the Drawings and the Specification; the Contractor shall execute the work in accordance with the decision of the Engineer-in-Charge. If modifications are necessary, the Contractor shall submit modifications to the Engineer-in-Charge for approval before such modifications are executed.

e) All Drawings and Specification are the property of the Engineer-in-Charge.

f) The Contractor will be required to give and obtain all necessary site and other particulars and to agree such details with the Engineer-in-Charge. The Contractor must also obtain details of any other Contractor's work affected by his work and shall work in close co-operation with all such firms or persons concerned.

g) The Contractor shall be responsible for any damage caused to buildings and contents and works by reason of, arising out of, or incidental to, or in connection with the execution of any work in the Contract Documents. The Contractor shall permit nothing to be done which may injure the stability of the Works, or existing buildings and no cutting through floors or walls will be allowed other than where required by the Drawings, without the sanction of the Engineer-in-Charge.

h) The Contractor shall submit to the Engineer-in-Charge for approval, before the work is commenced, a copy of all working details and installation drawings and shall also supply sufficient copies for the use of the Owner/Civil Work Contractor etc. These drawings must be submitted by the Contractor as soon as possible after the order is placed to give ample time for all parties concerned to study and comment thereon.

i) The work described on any working drawings submitted shall be carefully checked by the Contractor for all clearance, field conditions, maintenance of architectural conditions and proper co-ordination with all trades on the job. To this end, the Contractor, during the construction drawing stage, shall ensure that he co-ordinates drawings of all other trades that might interferes with the proper installation of his work. No payment shall be made for any variations or alterations on site due to lack of knowledge of other trades. Any unresolved conflict between various trades shall be referred to the Engineer-in-Charge. The equipment layout is to be detailed on the drawings, showing the exact method of installing and clearly illustrating components to be used in making all connections.

j) Pipework drawings must be fully detailed, showing all pipework in double line and indicating the precise size of fittings, valves and equipment, position of hanger supports with reference numbers must be indicated and a large scale detail must be given, showing the type and method of installation of each type of hanger. A schedule is to be included on each drawing, showing details of the type of hanger fixings and references number for each type. All general layout drawings shall be drawn 1/50 scale, unless agreed otherwise with the Engineer-in-Charge. Toilet piping layouts, details and hangers, cleanouts, methods of fixing of all fittings and fixtures including pipes, detailed cross sections of service ducts, etc., are to be drawn to 1/10 scale.

k) The Contractor shall provide a detailed programme incorporating working drawing production which can be read in conjunction with the building construction programme.

l) The Contractor shall prepare schedules and drawings showing precise details of holes in concrete, block works etc., base frames or support required and the like. The schedules shall show in detail the builder's work required to be performed by all other trades for the mechanical and electrical installations. These drawings and schedules, in an approved form, must be submitted to Engineer-in-Charge for approval before any structural work requiring holes or other modifications is constructed.

m) The Contractor shall submit all drawings as prescribed hereunder. All drawings shall be supplied in the form of a second negative and signed by a principal of the Contractor. After approval, the negative will be signed by the Engineer-in-Charge and returned to

the Contractor. The Engineer-in-Charge will take as many prints from this negative as he requires for his own use. Signed and approved drawings will not be departed from unless a signed variation or omission certificate is issued in writing by the Engineer-in-Charge. Drawings returned to the Contractor for alteration or amendment shall be re-submitted to the Engineer-in-Charge for approval. Amended or altered drawings shall show the nature of the amendment or alteration in a revision block on the drawing, together with the revision number or letter and the date of the revision.

n) Should the Contractor prove unable to produce satisfactory "Working Drawings" or be unable to produce drawings to conform to the progress of the work, the Engineer-in-Charge reserves the right to take whatever steps are necessary to have drawings undertaken by others and debit the Contractor's account.
Any decision taken by the Engineer-in-Charge to have working drawings produced elsewhere will not relieve the Contractor of his contractual obligations and the Contractor must provide to the Engineer-in-Charge all necessary details, physical dimensions, descriptive literature, etc., of all equipment to be incorporated on drawings within 10 days of a request from the Engineer-in-Charge.

16.4.2 Manufacturers' Data

a) Manufacturers' performance data, certified factory drawings of apparatus, giving full information as to capacity, dimensions, materials and all information pertinent to the adequacy of the submitted equipment shall be submitted for approval.
Manufacturer names, sizes, catalogue numbers and/or samples of all materials shall be submitted for approval. Submittals and working drawings should, as far as possible be complementary so that drawings and submittals can be cross checked.

c) Order of equipment submitted for approval must be accompanied by relevant drawings, technical data, catalogues and samples, where data, certified drawings or other required information is not available until after orders have been placed, the Engineer-in-Charge will give provisional approval until all requested drawings and information have been supplied to the Engineer-in-Charge and approved by him. It is the Contractor's responsibility to ensure that all necessary information is supplied to the Engineer-in-Charge in accordance with the progress of the work.

16.4.3 Operating and Maintenance Manual

The Contractor shall furnish six copies in bound form of an instruction manual containing all information applicable to this section of the Works. This manual is to be similar in design and content to those to be provided under other services.
The manual shall contain a comprehensive written description of the Works, outlining the operation of the systems and maintenance procedures.

16.4.4 “As Installed " Drawings

The Contractor shall arrange to keep on Site a full set of drawings showing the progress of the Works, which must be kept upto date.
The Contractor shall keep a record as the work proceeds of any work installed not in accordance with the drawings. On completion of the Works the Contractor shall supply three clear coloured prints of each applicable drawing, showing the exact position of all apparatus, pipe lines, services, control valves, switchgear, etc., together with diagrams, schedules, etc. to the Engineer-in-Charge's requirements and in addition one complete set of plastic negatives.
The word "AS INSTALLED DRAWINGS" shall be clearly indicated on all drawings adjacent to the title block.

16.5 WORK AND TIME SCHEDULE

The Contractor shall prepare a work and time schedule in a format as approved by Engineer-in-Charge. The schedule shall be submitted to Engineer-in-Charge within ten days of the award of the Contract. It shall indicate the expected date of commencement and completion of each item of work. The chart shall also indicate the Scheduling of samples, shop drawings and approvals. In addition to this, the Contractor shall also furnish to Engineer-in-Charge fortnightly progress reports indicating percentage completion of each item of work.

16.6 RATES

The rates quoted for any particular item by the bidder shall be inclusive of the cost of material, erection, connection, testing, labour, supervision, tools, plant, transportation, excise duties and taxes, contingencies, breakage, wastage and all other sundries for all levels.

The rate shall also be inclusive of cutting holes, making chases in RCC/brick work, inserting sleeves and making good the same with two hours fire rated materials. No claim for extra would be entertained on this account.

16.7 STANDARD AND CODES OF PRACTICE

The work shall be carried out as per the enclosed Specifications of Work and the construction drawings to be issued from time to time. These specifications shall be read in conjunction with CPWD specifications 2002 (with up-to-date correction slips), National Building Code 2005, relevant Codes of Practice and Standards as issued by Bureau of Indian Standards (B.I.S. - all with the latest amendments) wherever applicable, Fire Protection Manual & Sprinkler Regulations of Tariff Advisory Committee (TAC) & NFPA (USA) Publications.

A) General

SP : 6 (1)	Structural steel sections
IS : 27	Pig lead
IS : 325	Three phase induction motors
IS : 554	Dimensions for pipe threads where pressure tight joints are required on the threads.
IS : 694	PVC insulated cables for working voltages up to and including 1100 V.
IS : 779	Specification for water meters (domestic type)
IS : 782	Specification for caulking lead
IS : 800	Code of Practice for general construction in steel
IS : 1068	Electroplated coatings of nickel plus chromium and copper plus nickel plus chromium
IS : 1172	Code of basic requirements for water supply drainage and sanitation
IS : 1367 (Part- 1)	Technical supply conditions for threaded steel fasteners: Part 1 introduction and general information.
IS : 1367 (Part- 2)	Technical supply conditions for threaded steel fasteners: Part 2 product grades and tolerances.
IS : 1554 (Part- 1)	PVC insulated (heavy duty) electric cables: Part 1 for working voltages up to and including 1100V.
IS : 1554 (Part- 2)	PVC insulated (heavy duty) electric cables: Part 2 for working voltages from 3.3 kV up to and including 11 kV.
IS : 1726	Specification for cast iron manhole covers and frames
IS : 1742	Code of practice for building drainage.
IS : 2064	Selection, installation and maintenance of sanitary appliances – Code of practice.
IS : 2065	Code of practice for water supply in buildings.
IS : 2104	Specification for water meter boxes (domestic type)
IS : 2373	Specification for water meters (bulk type)
IS : 2379	Colour code for identification of pipe lines
IS : 2527	Code of practice for fixing rainwater gutters and down pipes for roof drainage.
IS : 2629	Recommended practice for hot dip galvanizing on iron and steel
IS : 3114	Code of practice for laying of cast iron pipes
IS : 4111 (Part 1)	Code of practice for ancillary structures in sewerage system : Part 1 manholes
IS : 4127	Code of practice for laying glazed stoneware pipes.
IS : 4853	Recommended practice for radiographic inspection of fusion welded butt joints in steel pipes
IS : 5329	Code of practice for sanitary pipe work above ground for buildings.

IS : 5455	Cast iron steps for manholes.
IS : 6159	Recommended practice for design and fabrication of material prior to galvanizing
IS : 7558	Code of practice for domestic hot water installations
IS : 8321	Glossary of terms applicable to plumbing work
IS : 9668	Code of practice for provision and maintenance of water supplies and fire fighting.
IS : 9842	Preformed fibrous pipe insulation
IS : 9912	Coal tar based coating materials and suitable primers for protecting iron and steel pipe lines.
IS : 10221	Code of practice for coating and wrapping of underground mild steel pipelines
IS : 10234	Recommendations for general pipeline welding.
IS : 10446	Glossary of terms relating to water supply and sanitation.
IS : 11149	Rubber Gaskets
IS : 11790	Code of practice for preparation of butt-welding ends for pipes, valves, flanges and fittings.
IS : 12183 (Part 1)	Code of practice for plumbing in multi-storeyed buildings : Part 1 Water supply
IS : 12251	Code of practice for drainage of building basements
IS : 5572	Code of practice for sanitary pipe work
IS : 6700	Specification for design, installation, testing and maintenance of services supplying water for domestic use within buildings and their cartilage.
IS : 8301	Code of practice for building drainage
BSEN : 274	Sanitary tapware, waste fittings for basins, bidets and baths. General technical specifications.

B) PIPES AND FITTINGS

IS : 458	Specification for precast concrete pipes (with and without reinforcement)
IS : 651	Salt glazed stone-ware pipes and fittings
IS : 1239 (Part 1)	Mild steel tubes, tubular and other wrought steel fittings Part 1 Mild Steel tubes
IS : 1239 (Part 2)	Mild steel tubes, tubular and other wrought steel fittings : Part 2 Mild steel tubular and other wrought steel pipe fittings.
IS : 1536	Centrifugally cast (spun) iron pressure pipes for water, gas and sewage
IS : 1537	Vertically cast iron pressure pipes for water, gas and sewage.
IS : 1538	Cast iron fittings for pressure pipes for water, gas and sewage
IS : 1729	Sand cast iron spigot and socket soil, waste and ventilating pipes, fittings and accessories
IS : 1879	Malleable cast iron pipe fittings
IS : 1978	Line pipe
IS : 1979	High test line pipe
IS : 2501	Copper tubes for general engineering purposes
IS : 2643 (Part 1)	Dimensions for pipe threads for fastening purposes: Part 1 Basic profile and dimensions.
IS : 2643 (Part 2)	Dimensions for pipe threads for fastening purposes: Part 2 Tolerances
IS : 2643 (Part 3)	Dimensions for pipe threads for fastening purposes: Part 3 Limits of sizes.
IS : 3468	Pipe nuts
IS : 3589	Seamless or electrically welded steel pipes for water, gas and sewage (168.3 mm to 2032 mm outside diameter)
IS : 3989	Centrifugally cast (spun) iron spigot and socket soil, waste and ventilating pipes, fittings and accessories.
IS : 4346	Specifications for washers for use with fittings for water services.
IS : 4711	Methods for sampling steel pipes, tubes and fittings
IS : 6392	Steel pipe flanges
IS : 6418	Cast iron and malleable cast iron flanges for general engineering purposes.
IS : 7181	Specification for horizontally cast iron double flanged pipe for water, gas and sewage.

C) VALVES

IS : 778	Specification for copper alloy gate, globe and check valves for water works purposes
IS : 14846	Specification for sluice valves for water works purposes (50 mm to 1200 mm size)
IS : 1703	Specification copper alloy float valves (horizontal plunger type) for water supply fittings
IS : 2906	Specification for sluice valves for water works purposes (350 mm to 1200 mm size)
IS : 3950	Specification for surface boxes for sluice valves
IS : 5312 (Part 1)	Specification for swing check type reflux (non-return) valves : Part 1 Single door pattern
IS : 5312 (Part 2)	Specification for swing check type reflux (non-return) valves : Part 2 Multi door pattern
IS : 12992 (Part 1)	Safety relief valves, spring loaded : Part 1 – Design
IS : 13095	Butterfly valves for general purposes.

C) FIRE FIGHTING EQUIPMENT

TAC	Tariff advisory committee fire protection manual Part I
TAC	Rules of Tariff Advisory Committee for Automatic Sprinkler system
NFPA : 12, 1993	Standards on Carbon Dioxide Extinguishing System
IS : 636	Non- percolating flexible fire fighting delivery hose
IS : 884	Specification for First Aid Hose Reel for fire fighting
IS : 901	Specification for first aid hose reel for fire fighting
IS : 902	Specification for couplings, double male and double female, instantaneous pattern for fire fighting
IS : 903	Suction hose coupling for fir fighting purposes
IS : 904	Specification for fire hose delivery couplings, branch pipe, nozzles and nozzle spanner
IS : 905	Specification for 2-way and 3-way suction collecting heads for fire fighting purposes
IS : 907	Specification for delivery breechings, dividing and collecting instantaneous pattern for fire fighting purposes
IS : 908	Specification for suction strainers, cylindrical type for fire fighting purposes.
IS : 909	Specification for underground fire hydrant, sluice valve type
IS : 910	Specification for combined key for hydrant, hydrant cover and lower valve.
IS : 15683	Specification for portable chemical foam fire extinguisher
IS : 1648	Code of practice for fire safety of building (general) : Fir fighting equipment and its maintenance.
IS : 15683	Specification for portable fire extinguishers dry powder (cartridge type)
IS : 2190	Selection installation and maintenance of first-aid fire extinguishers- Code of practice
IS : 2871	Specification for branch pipe, universal for fire fighting purposes.
IS : 15683	Specification for fire extinguishers, carbon dioxide type (portable and trolley mounted)
IS : 3844	Code of practice for installation and maintenance of internal fire hydrants and hose reel on premises
IS : 5290	Specification for landing valves
IS : 5714	Specification for hydrant, stand pipe for fire fighting
IS : 8090	Specification for coupling, branch pipe, nozzle, used in hose reel tubing for fire fighting
IS : 8423	Specification for controlled percolation type hose for fire fighting
IS : 10658	Specification for higher capacity dry powder fire extinguisher (trolley mounted)
IS : 11460	Code of practice for fire safety of libraries and archived buildings
IS : 13039	External hydrant system – provision and maintenance – Code of practice.
IS : 5514 (Parts 1 to 7)	Reciprocating internal combustion engines: performance.

D) WATER QUALITY TOLERANCE

IS : 3025 (Part 1 to 44)	Method of sampling and test (physical and chemical) for water and waste water
IS : 4764	Tolerance limits for sewage effluents discharged into inland surface waters
IS : 10500	Drinking water

E) PUMPS AND VESSELS

IS : 1520	Specification for horizontal centrifugal pumps for clear cold fresh water
IS : 2002	Steel plates for pressure vessels for intermediate and high temperature service including boilers
IS : 2825	Code for unfired pressure vessels
IS : 4682 (Part 1)	Code of practice for lining of vessels and equipment for chemical processes Part 1 : Rubber lining
IS : 5600	Specification for sewage and drainage pumps

IS : 8034	Specification for submersible pump sets for clear, cold, fresh water
IS : 8418	Specification for horizontal centrifugal self-priming pumps

16.8 FIRE FIGHTING INSTALLATION DRAWINGS

The Fire Fighting Installation drawings issued from time to time to the Contractor are diagrammatic but shall be following as closely as actual construction and work will permit. Any deviation from the drawings required to conform to the building construction shall be made by the Contractor at his own expenses. The architectural drawings shall take precedence over the services drawings as far as the Civil and other trades works are concerned.

DISCREPANCIES IN THE DRAWINGS

Should there be any discrepancy due to in -complete description, ambiguity or omission in the drawings and other documents relating to this Contract found by the Contractor either before starting the work or during execution or after completion, the same shall be immediately brought to the attention of the Engineer-in-Charge and his decision would be final and binding on the Contractor.

16.9 CO-ORDINATION WITH OTHER TRADES

The Contractor shall be responsible for coordinating this work with works of other trades sufficiently ahead of time to avoid unnecessary hold ups. Hangers, sleeves, recesses etc. shall be left in time as the work proceeds.

16.10 INSTRUMENTS FOR MEASUREMENT AND TESTING

The Contractor shall provide, free of cost, all equipments, instruments, labour and all other allied assistance required by the Owner/ Engineer-in-Charge or their representatives for measurement and testing of the works.

16.11 UP-KEEP OF THE SITE

It shall be the responsibility of the Contractor to clear away, from time to time, all debris and excess material generated by the activities of his workers.

16.12 PROTECTION

All work shall be adequately protected, to the satisfaction of the Engineer-in-Charge, so that the whole work is free from the damage throughout the period of construction upto the time of handing over.

Special care must be taken to prevent damage and scratching of all fittings and fixtures. Tool marks on exposed fixtures shall not be accepted. Protective paper on fixtures shall be removed with hot water only at the final completion of the work.

Before handing over the work, the Contractor shall clean all elements of the complete installation, remove plasters, splashes, stickers, rust stains and all other foreign matter and leave every part in acceptable condition and ready for use to the satisfaction of the Engineer-in-Charge.

16.13 SYSTEM SPECIFICATION

16.13.1 INTERNAL HYDRANT

The Internal hydrant provided near the staircases shall cover the entire building internally with landing valves, hose reel, C.P hose pipe, Branch pipe, M.S Boxes/Shutter provided at appropriate location.

16.13.2 DOWN COMER SYSTEM

The Down Comer system shall comprises of AC motor driven pump set installed at Terrace near the over head tank, associated instruments, cabling, piping, valves, control panel etc and any other component required to complete the system in all respect. The Down Comer system shall cover various areas as marked in the drawings.

16.13.3 PRESSURISATION SYSTEM:

a) This system shall comprises of one (1) No. Terrace pump with electric motor.

b) The down comer system shall be kept pressurised all the times through the Terrace pump. The pump shall start automatically upon getting impulse from the pressure switch on drop of pressure in the pipe lines.

c) Mode of Operation:

(i) The pressure in the down comer pipe network shall be kept constant at 3 Kg/Sqcm near the pump and approximately 4.5 Kg/Sqcm. at Ground Floor. In the event of fire, when one or more valves are opened, the fire pump shall start automatically.

(ii) The setting of the pressure switches shall be adjustable so that any desirable sequence of starting may be achieved at site.

(iii) In addition to auto start arrangements, the pump shall also have an overriding manual starting facility by push button arrangement in case of an emergency.

16.13.4 Internal Hydrant (Accessories):

(i) The internal hydrant system shall be provided at every floor/platform level and at landing staircases. The hydrant point shall be directly tapped from riser pipes in accordance with the statutory requirement.

(ii) One single headed gun metal landing valve with 63 mm dia outlets and 80 mm dia inlets conforming to IS-5290 with cast iron wheels shall be provided. Landing valves shall have flanged inlet and instantaneous female type outlets.

(iii) First Aid Hose Reel Drum directly tapped from the Wet Riser pipe with 25 mm dia gun metal gate valve and fittings etc. with 3o meters of 20 mm dia high pressure rubber pipe with shut off nozzles 1 set.

(iv) Internal Hydrant shall have 63 mm dia 2 nos. 15 meter long confirming to IS-8423 complete with ISI marked male and female coupling and one number 63 mm dia ISI marked gunmetal short branch pipe with nozzle.

(v) M.S. Hose Cabinet with glass front door and locking arrangements shall be provided at each landing. M.S. hose cabinet shall be constructed out of 16 gauge (1.6 mm) mild steel sheet and duly painted in approved finish. The cabinet shall be sufficient enough to accommodate first-aid hose reel and two canvas hoses of 63 mm dia & 15 meter long.

(vi) The hydrant riser shall be terminated with air release valve at the highest points to release the trapped air in the piping network.

16.13.5 Fire Brigade Inlet Connection:

Fire brigade inlet connection shall be of gun metal with three 63 mm dia instantaneous type inlets with leak proof built in type check valves and 150 mm dia flanged outlet connections feeding to the main fire grid. The collecting head shall conform to IS-904.

16.13.6 Hose Reels:

(i) Swinging hose reels conforming to IS-884 shall be with rubber hose of 20 mm (3/4") diameter, 3 Ply rating and suitable for 350 psig bursting pressure. The reel shall be fabricated out of heavy gauge pressed mild steel capable of swinging up to 170 degree rotation. The movement of the reel shall be friction less and shall be provided with suitable bearings. Gun metal packing glands shall be provided with adjustable nuts.

(ii) The swinging hose reels shall be complete with the following accessories.

(a) Shut-off nozzle of gun metal duly chromium plated complete with control valve suitable for throw of 40-45 ft. at 60 psig pressure.

(b) Wall bracket with U shape reel carrier made out of cast iron.

(c) G.M. isolation valve.

16.13.6.1 HAND HELD APPLICATIONS:

Installation of fully charged and tested fire extinguishing hand appliances CO2, and water type (capacity and location as shown on drawings) as required.

16.14.0 OTHER REQUIREMENTS

a) Fire extinguishers shall conform to the relevant Indian Standards.

b) The portable fire extinguishers i.e water CO2 type fire extinguishers having cap. 9 ltr and CO2 type fire extinguisher having cap. 4.5 kg shall be provided at strategic locations as indicated on the drawings. The number of fire extinguishers must be installed and maintained in accordance with IS:2190.

c) Hand held appliances shall be installed in readily accessible locations with the appliance brackets fixed to wall by suitable anchor fasteners or by means of floor mounted supports. Alternatively, they shall be installed within hose reel cabinets.

d) Each appliance shall be provided with an inspection card indicating the date of inspection, testing, changes of charge and other relevant data.

e) All appliances shall be fixed in a true workman like manner truly vertical and at correct locations. Identical type of extinguishers shall be of same make and shall have similar method of operation.

16.15.0 FIRE PUMPS & ACCESSORIES:

16.15.1 PUMP CONSTRUCTION:

(i) The electrical pump shall be designed for continuous operation and shall have a Continuously rising head characteristics without any zone of instability. The pump shall conform as per IS-1520-1660, IS-9079, IS-325 and shall be of the following construction:

	Pump Description	**Horizontal Split Casing Double Suction**
1.	Casing	Cast Iron/Cast Steel
2.	Impeller	Bronze
3.	Shaft	High Tenstile Steel
4.	Bearings	Heavy duty Ball/ Roller Bearings
5.	Base Plate	Cast Iron/ Fabricated M.S.
6.	Flanges	Conforming to ISS 1536/1960
7.	Packing	Mechanical Seal
8.	Max. Speed	1500 RPM/2900 RPM
9.	Driver	TEFC
10.	Starter	DOL

(ii) Pump and driver shall be mounted on a single bed-plate and directly driven through flexible coupling.

(iii) The pumps shall be of the type approved by TAC and capable of delivering not less than 150 % of rated capacity at a head of not less than 65% of the rated head. The shut off head of pump shall not exceed 120% of the rated head. The drive motor shall be continuous rating type and its rating shall be at least equivalent to the horse power required to drive the pump at 150% of its rated discharge.

16.16 ACCESSORIES AND FITTINGS:

16.16.1 The following accessories shall be provided with each pump among other standard
Accessories required:

a) Coupling guard for horizontal split casing pumps.

b) Lubrication fittings and seal piping.

c) Test and/or air vent cocks.

16.16.2 Following fittings shall be provided with each pump among other standard fittings required :

a) Suction and discharge shut off valves (gate type) and discharge check valves as specified under section "Piping".

b) Pressure gauge at discharge of size not less than 100 mm dia and of the appropriate rating with gauge valves etc.

c) 25 mm GI gland drain.

16.17.0 WATER PIPING:

16.17.1 GENERAL

a) All piping laid shall be as follows:

Pipe Size	**Material**	**Joints & Fittings**	**Sealing Materials**
Upto 50 mm	G.I pipe Heavy Class IS-1239/1979	Screwed fittings Unions Raised face Slip-on flanges	Non-hardening Lubricant
Above 50 mm to 150 mm	G.I. pipe Heavy Class IS-1239/1979	Welded fittings Raised face Slip-on flanges --	--- 3 mm, 3-ply rubber insertion

Pipe threads shall be to IS-554 and flanges to IS-1536.

b) All piping shall be black steel unless otherwise stated. Pipes shall be given one primary coat of red oxide paint & 2 coats of synthetic enamel paint of approved color before being installed. Pipes shall be sloping towards drain points.

c) Fittings shall be new and from reputed manufacturers, fittings shall be of malleable casting of pressure rating suitable for the piping system. Fittings used on welded piping shall be of the weldable type. Flanges shall be new and from standard manufacturers. Supply of flanges shall include bolts, washers gaskets etc as required.

d) Tee-off connection shall be through reducing tees, wherever possible. Otherwise ferrules welded to the main pipe shall be used. Drilling and tapping of the walls of the main pipe shall not be resorted to.

e) All equipment and valve connections shall be through flanges (Welded or screwed for mild steel).

f) All welded piping is subjected to the approval of the Construction Manager and sufficient number of flanges and unions shall be provided.

g) Gate valves/water type Butterfly valves shall be provided as required or as shown in the applicable shop drawings conforming to the following specification:

h) Gate valves shall conform to IS-780/1969, Flanges to IS-1536 or as required. Valves shall have non-rising spindles unless otherwise specified and shall be suitable for 21 Kg/Sqcm test pressure. Tail pieces shall be used where required.

i) Butterfly valves shall conform to BS-5155, MSS SP 67 & API 609 and designed to fit without gaskets between mating flanges. The valves shall be suitable for flow in either direction and seal in both directions. The valve shall be of integral moulded design.

j) Check valves shall be provided as required or as shown on the drawings and conform to the following specifications:

Size	**Connection**	**Ends**
12 mm to 50 mm	Gun Metal	Screwed Female
65 mm and above	Gun Metal/C.I.	Flanged

Swing check valves shall normally be used in all water services. Lift type valves may be used in horizontal runs. Air release and clean out plugs shall be provided and valves shall be suitable for 21 Kg/Sqcm test pressure.

k) Strainers shall be preferably of the approved type with C.I. bodies designed to the test pressures specified for the gate valves. Strainers shall have removable bronze screen with 3mm perforations and a permanent magnet. Strainers shall be provided with flanges or threaded sockets as required. They shall be designed so as to enable blowing out accumulated dirt and facilitate removal and replacement of screen without disconnection of the main pipe. All strainers shall be provided with equal size isolating gate valves with rising spindles so that the strainer may be cleaned without draining the system. Strainers shall be provided on the suction side of each pump; and wherever shown in the drawings.

16.17.2 PIPING INSTALLATION:

a) The drawings indicate schematically the size and location of pipes. Pipes runs and sizes may, however, be changed to meet the site conditions. The contractor on the award of the work, shall prepare detailed working drawings showing the cross section, longitudinal section, detail of fittings, locations of isolating drain and air valves etc. They must keep in view the specific openings in buildings and other structures through which the pipes are designed to pass. This working drawing will be approved by the Construction Manager before commencement of work.

b) Piping shall be properly supported on or suspended from stands, clamps, hangers etc, as specified and as required. The tender shall adequately design all the brackets, saddles, clamps, hangers etc and be responsible for their structural integrity.

c) Pipe supports shall be of steel, adjustable for height and primer coated with rust preventive paint and finish coated black. Where pipe and clamp are of dissimilar material, a gasket shall be provided in between.

d) Spacing of pipe supports shall not exceed the following:

Pipe Size (mm)	**Spacing (M)**
3 to 12	1.22
19 to 25	1.83
32 to 150	2.44
150 to above	3.05

Pipe hangers shall be fixed on walls and ceilings by means of metallic rawl plugs.

e) Vertical risers shall be parallel to walls and column lines and shall be straight and plumb. Risers passing from floor to floor shall be supported at each floor by clamps or collars attached to pipe and with a 12mm thick ribbed rubber pad or any other approved resilient material. Where pipes pass through the terrace floor, suitable curbing shall be provided to prevent water leakage. Risers shall also have a suitable concrete pipes support at the lowest point.

f) Piping work shall be carried out with minimum disturbance to the other works being done at the sites. A program work shall be chalked out in consultation with the construction manager and approved by him.

g) Piping layout shall take due care for expansion and contraction in pipes.

h) All pipes using screwed fitting shall be accurately cut to the required sizes and thread in accordance with IS-554 and burrs removed before laying. Wherever reducers are to be made horizontal runs , eccentric reducers shall be used if the piping is to drain freely, in other location, concentric reducers may use.

i) Air valves shall be provided at all high points in the piping system for venting. Valves shall be of the double float type, with G.M./C.I. body, vulcanite balls, rubber seating etc. Air valves shall be of the sizes specified and shall be associated with an equal size gate valve with rising spindle.

Mains	Air Valves
Up to 100 mm dia	25 mm dia

Discharge from the air valves shall be piped through an equal sized G.I pipe to the nearest drain or floor waste or as shown.

j) All buried pipes shall be cleaned and coated with zinc chromate primer and bituminous paint, than wrapped with two layers of fiberglass felt each layer laid in bitumen.

16.17.3 PRESSURE GAUGES:

16.17.3.1 Pressure gauge shall be not less than 100 mm dia dial and of appropriate range and be complete with shut off gauge valve etc duly calibrated before installation.

16.17.3.2 Pressure gauge shall be provided at the following locations and as indicated on the drawings & schedule of quantities.

Care shall be taken to protect pressure gauges during pressure testing.

16.17.4 VIBRATION ELIMINATION:

Piping installation shall be carried out with vibration elimination fittings wherever required.

16.17.5 TESTING:

a) All piping shall be holiday testing 1.5 times pressure to withstand hydrostatic test pressure of 10.5 Kg/Sq cm for the design pressure for a period of not less than 24 hours. All leaks and defects in joints revealed during the testing shall be rectified to the satisfaction of the Construction Manager.

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

c) Systems may be tested in sections and such sections shall be securely capped.

d) The Project Manger shall be notified well in advance by the contractor of his intention to test a section of piping and all testing shall be witnessed by the Construction Manger.

16.17.6 PAINTING:

16.17.6.1 After the piping has been installed, tested and run for at least ten days. The piping shall be given two finish coats, 3 mils each of approved colour.

16.17.6.2 The direction of flow of fluid in the pipes shall be visibly marked in white arrows or as directed by the Construction Manager.

HVAC WORKS

1 GENERAL

The specification covers manufacture as necessary, testing, delivery at site, all preparatory work, assembly and installation, final testing and commissioning.

The work shall be executed as per CPWD General Specifications for HVAC works 2004, CPWD General Specifications for Electrical works Part-I, II & IV as amended up to date, relevant IE Rules; relevant IS as per directions of Engineer in Charge. These additional specifications & conditions are to be read in conjunction with above and in case of variations, specifications given in additional specifications & conditions shall apply. However, nothing extra shall be paid on account of these as the same are to be read along with schedule of quantities for the work.

1.1 HVAC DRAWINGS

The HVAC drawings issued from time to time to the Contractor are diagrammatic but shall be followed as closely as actual construction and work will permit. Any deviation from the drawings required to conform to the building construction shall be made by the Contractor at his own expenses. The architectural drawings shall take precedence over the services drawings as far as the Civil and other trade works are concerned.

DISCREPANCY IN DRAWINGS

Should there be any discrepancy due to in -complete description, ambiguity or omission in the drawings and other documents relating to this Contract found by the Contractor either before starting the work or during execution or after completion, the same shall be immediately brought to the attention of the Engineer-in-Charge and his decision would be final and binding on the Contractor.

1.2 INSTRUMENTS FOR MEASUREMENT AND TESTING

The Contractor shall provide, free of cost, all equipments, instruments, labour and all other allied assistance required by the Engineer-in-Charge for measurement and testing of the works.

1.3 CO-ORDINATION WITH OTHER TRADES

The Contractor shall be responsible for coordinating this work with works of other trades sufficiently ahead of time to avoid unnecessary hold ups. Hangers, sleeves, recesses etc. shall be left in time as the work proceeds.

1.4 GUARANTEE

The contractor shall guarantee the complete system to maintain the specified conditions under all conditions of ambience and internal loads subject to the condition that designed outside conditions & designed internal loads are not exceeded. Also the inlet/ outlet temperatures at the specified flow of water in the chiller unit shall be guaranteed.

All equipment shall be guaranteed for a period of 12 months from the date of acceptance and taking over of the installation by the Department against unsatisfactory performance and or breakdown due to defective design, material, manufacture, workmanship or installation. The equipment or component or any part thereof so found defective during the guarantee period shall be repaired or replaced free of cost to the satisfaction of the Engineer-in-charge. In case the department feels it the contractor in doing this, the same will be got done by the department at the risk & cost of the contractor. The decision of the Engineer-in-charge in this regard shall be final. Any leakage of refrigerant and / or oil due to defective design manufacture, workmanship or installation during the guarantee period shall be made good by the contractor free of charge.

1.5 SHOP DRAWINGS

All the shop drawings shall be prepared on computer through AutoCAD System based on Architectural Drawings and site measurements. All heat load calculations shall be done using approved computer program. Within one weeks of the award of the contract, contractor shall furnish, for the approval of the Consultants/Engineer, two sets of detailed shop drawings of all equipment and materials including layouts fan rooms, ventilation fans; detailed ducting

drawings showing exact location of supports, flanges, bends, tee connections, reducers, guide vanes, silencers, distribution grids, volume control dampers, collars, grilles, diffusers; detailed piping drawings showing exact location and type of supports, valves, fittings etc; acoustic lining and external insulation details for ducts, pipe insulation etc; electrical panels inside/outside views, power and control wiring schematics, cable trays, supports and terminations. These shop drawings shall contain all information required to complete the Project as per specifications and as required by the Engineer - in - Charge.

These Drawings shall contain details of construction, size, arrangement, operating clearances, performance characteristics and capacity of all items of equipment, also the details of all related items of work by other contractors. Each shop drawing shall contain tabulation of all measurable items of equipment/materials/works and progressive cumulative totals from other related drawings to arrive at a variation-in-quantity statement at the completion of all shop drawings. Minimum 12 sets of drawings shall be submitted after final approval along with CD.

Each item of equipment/material proposed shall be a standard catalogue product of an established manufacturer strictly from the manufacturers listed in List of approved Makes.

When the Engineer-in-Charge makes any amendments in the above drawings, the contractor shall supply two fresh sets of drawings with the amendments duly incorporated along with check prints, for approval. The contractor shall submit further twelve sets of shop drawings to the Engineer-in-Charge for the exclusive use by the Engineer-in-Charge and all other agencies. No material or equipment may be delivered or installed at the job site until the contractor has in his possession, the approved shop drawing for the particular material/equipment/installation.

1.5.1 Shop drawings shall be submitted for approval sufficiently in advance of planned delivery and installation of any material to allow Engineer-in-Charge ample time for scrutiny. No claims for extension of time shall be entertained because of any delay in the work due to his failure to produce shop drawings at the right time, in accordance with the approved programme.

1.5.2 Manufacturer's drawings, catalogues, pamphlets and other documents submitted for approval shall be in four sets. Each item in each set shall be properly labelled, indicating the specific services for which material or equipment is to be used, giving reference to the governing section and clause number and clearly identifying in ink the items and the operating characteristics. Data of general nature shall not be accepted.

1.5.3 Samples of all materials like grilles, diffusers, controls, insulation, cables, control wires etc shall be submitted to the Engineer-in-Charge prior to procurement. These will be submitted in two sets for approval and retention by Engineer-in-Charge and shall be kept in their site office for reference and verification till the completion of the Project.

1.5.4 Approval of shop drawings shall not be considered as a guarantee of measurements or of building dimensions. Where drawings are approved, said approval does not mean that the drawings supersede the contract requirements, nor does it in any way relieve the contractor of the responsibility or requirement to furnish material and perform work as required by the contract.

1.5.5 Where the contractor proposes to use an item of equipment, other than that specified or detailed on the drawings, which requires any redesign of the structure, partitions, foundation, piping, wiring or any other part of the mechanical, electrical or architectural layouts; all such re-design, and all new drawings and detailing required therefore, shall be prepared by the contractor at his own expense and gotten approved by the Engineer-in-Charge.

1.5.6 Where the work of the contractor has to be installed in close proximity to, or will interfere with work of other trades, he shall assist in working out space conditions to make a satisfactory adjustment. If so directed by the Engineer, the contractor shall prepare composite working drawings and sections at a suitable scale, not less than 1:50, clearly showing how his work is to be installed in relation to the work of other trades. If the Contractor installs his work before coordinating with other trades, or so as to cause any interference with work of other trades, he shall make all the necessary changes without extra cost to the Owner.

1.5.7 Within one weeks of approval of all the relevant shop drawings, the contractor shall submit four copies of a comprehensive variation in quantity statement, and itemized price list of

recommended (by manufacturers) imported and local spare parts and tools, covering all equipment and materials in this contract.

1.6 AS-FITTED' DRAWINGS

The Contractor shall submit, after the completion of the work, one set of originals and two sets of prints of the 'As-Fitted' drawings, giving the following information.

c) Position of all light, fan and other outlets, MDBs & SDBs.
d) Conduit layout.
e) Single line diagram for internal works.
f) External lighting schemes, cable route etc.

1.7 OPERATION & MAINTENANCE MANUALS

The Contractor shall hand over to the Owner all operation and maintenance manuals of the plant and equipment supplied and installed by him. Only manufactures catalogues wiring diagrams and installation drawings, relevant to particular items of equipment concerned shall be submitted. General catalogues will not be accepted.

1.8 QUIET OPERATION AND VIBRATION ISOLATION

All equipment shall operate under all conditions of load without any sound or vibration which is objectionable in the opinion of the Engineer-in-Charge. In case of rotating machinery sound or vibration noticeable outside the room in which it is installed, or annoyingly noticeable inside its own room, shall be considered objectionable. Such conditions shall be corrected by the Contractor at his own expense. The contractor shall guarantee that the equipment installed shall maintain the specified NC levels.

1.9 ACCESSIBILITY

The Contractor shall verify the sufficiency of the size of the shaft openings, clearances in cavity walls and suspended ceilings for proper installation of his ducting and piping. His failure to communicate insufficiency of any of the above, shall constitute his acceptance of sufficiency of the same. The Contractor shall locate all equipment which must be serviced, operated or maintained in fully accessible positions. The exact location and size of all access panels, required for each concealed control damper, valve or other devices requiring attendance, shall be finalized and communicated in sufficient time, to be provided in the normal course of work. Failing this, the Contractor shall make all the necessary repairs and changes at his own expense.

1.10 MANUFACTURERS INSTRUCTIONS

Where manufacturer has furnished specific instructions, relating to the material and equipment used in this project, covering points not specifically mentioned in these documents, such instructions shall be followed in all cases.

1.11 ELECTRICAL INSTALLATION

The electrical work related to air conditioning services, shall be carried out in accordance with specifications of Electrical Works and with the complete coordination. The electrical installation shall be in total conformity with the control wiring drawings prepared by the contractor and approved by the Engineer -in-Charge. All air conditioning equipment shall be connected and tested in the presence of an authorized representative of the contractor.

The air conditioning system shall be commissioned only after the contractor has certified in writing that the electrical installation work for air conditioning services has been thoroughly checked, tested and found to be totally satisfactory and in full conformity with the contract Drawings, Specifications and manufacturer's instructions.

g) VARIABLE REFRIGERANT VOLUME SYSTEM

2.1 TYPE

Units shall be air cooled, variable refrigerant volume air conditioner consisting of one outdoor unit and multiple indoor units. Each indoor units having capability to cool or heat independently for the requirement of the rooms.

The indoor units on any circuit can be of different type and also controlled individually.
Following type of indoor units shall be connected to the system:

h) Ceiling mounted Ductable type (High Static)
i) Ceiling mounted Ductable type (Medium Static)
j) Ceiling mounted Ductable type (Low Static)
k) Ceiling Mounted Cassette Type
l) Wall mounted type (Multi Flow Type)
m) Floor Standing type

Compressor installed in outdoor unit shall be equipped with inverter controller, and capable of changing the rotating speed to follow variations in cooling and heating load.

Outdoor unit shall be suitable for mix match connection of all type of indoor units.

The refrigerant piping between indoor units and outdoor unit shall be extended up to 150m with maximum 50m level difference without any oil traps.

Both indoor units and outdoor unit shall be factory assembled, tested and filled with first charge of refrigerant before delivering at site.

2.2 OUTDOOR UNIT

The outdoor unit shall be factory assembled, weather proof casing, constructed from heavy gauge mild steel panels and coated with baked enamel finish. The unit should be completely factory wired, tested with all necessary controls and switch gears:

n) All outdoor units above 5 HP shall have minimum two scroll compressors and be able to operate even in case one of compressor is out of order.

o) In case of outdoor units with multiple compressors, the operation shall not be disrupted with failure of any compressor.

p) It should also be provided with duty cycling for switching starting sequence of multiple outdoor units.

q) The noise level shall not be more than 60 dB(A) at normal operation measured horizontally 1m away and 1.5m above ground level.

r) The outdoor unit shall be modular in design and should be allowed for side by side installation.

s) The unit shall be provided with its own microprocessor control panel.

The outdoor unit should be fitted with low noise, aero spiral design fan with large airflow and should be designed to operate compressor linking technology. The unit should also be capable to deliver 55 Pa external static pressure to meet long exhaust duct connection requirement.

2.3 COMPRESSOR

The compressor shall be highly efficient scroll type and capable of inverter control. It shall change the speed in accordance to the variation in cooling or heating load requirement:

t) All outdoor units shall have at least 10 steps of capacity control to meet load fluctuation and indoor unit individual control. All parts of compressor shall be sufficiently lubricated stock. Forced lubrication may also be employed.

u) Oil heater shall be provided in the compressor casing.

2.4 HEAT EXCHANGER

The heat exchanger shall be constructed with copper tubes mechanically bonded to aluminum fins to form a cross fin coal. The aluminum fins shall be covered by anti-corrosion resin film.

2.5 REFRIGERANT CIRCUIT

The refrigerant circuit shall include liquid & gas shut-off valves and a solenoid valves at condenser end.

2.6 SAFETY DEVICES

All necessary safety devices shall be provided to ensure safe operation of the system.

Following safety devices shall be part of outdoor unit; high pressure switch, fuse, crankcase heater, fusible plug, over load relay, protection for inverter, and short recycling guard timer.

2.7 OIL RECOVERY SYSTEM

Unit shall be equipped with an oil recovery system to ensure stable operation with long refrigeration piping lengths.

2.8 INDOOR UNIT

This section deals with supply, installation, testing, commissioning of various type of indoor units confirming to general specification and suitable for the duty selected. The type, capacity and size of indoor units shall be as specified in detailed Bill Of Quantities

2.9 GENERAL

Indoor units shall be either ceiling mounted cassette type, or ceiling mounted ductable type or floor standing type or wall mounted type or other as specified in BOQ. These units shall have electronic control valve to control refrigerant flow rate respond to lead variations of the room.

a) The address of the indoor unit shall be set automatically in case of individual and group control.
b) In case of centralized control, it shall be set by liquid crystal remote controller.

The fan shall be dual suction, aerodynamically designed turbo, multi blade type, statically & dynamically balanced to ensure low noise and vibration free operation of the system. The fan shall be direct driven type, mounted directly on motor shaft having supported from housing. The cooling coil shall be made out of seamless copper tubes and have continuous aluminum fins. The fins shall be spaced by collars forming an integral part. The tubes shall be staggered in the direction of airflow. The tubes shall be hydraulically/ mechanically expanded for minimum thermal contact resistance with fins. Each coils shall be factory tested at 21kg/sqm air pressure under water.

Unit shall have cleanable type filter fixed to an integrally moulded plastic frame. The filter shall be slide away type and neatly inserted.

Each indoor unit shall have computerized PID control for maintaining design room temperature. Each unit shall be provided with microprocessor thermostat for cooling and heating.

Each unit shall be with wired LCD type remote controller. The remote controller shall memorize the latest malfunction code for easy maintenance. The controller shall have self-diagnostic features for easy and quick maintenance and service. The controller shall be able to change fan speed and angle of swing flat individually as per requirement.

2.9.1 Ceiling Mounted Cassette Type Indoor Unit (Multi Flow Type)

The unit shall be ceiling mounted type. The unit shall include pre-filter, fan section and DX-coil section. The housing of the unit shall be powder coated galvanized steel. The body shall be light in weight and shall be able to suspend from four corners.
Unit shall have an external attractive panel for supply and return air. Unit shall have four way supply air grilles on sides and return air grille in center.

Each unit shall have high lift drain pump, fresh air intake provision (if specified).Low gas detection system and very low operating sound.

All the indoor units regardless of their difference in capacity should have same decorative panel size for harmonious aesthetic point of view. It should have provision of connecting branch ducts.

2.9.2 Ceiling Mounted Ductable Type Indoor Unit

Unit shall be suitable for ceiling mounted type. The unit shall include pre filter, fan section & DX coil section. The housing of unit shall be light weight powder coated galvanized steel. The unit shall have high static fan for Ductable arrangement.

2.9.3 Ceiling Suspended Indoor Type

Unit shall be suitable for ceiling suspended arrangement below false ceiling. The unit include pre filter, fan section & DX coil section. The housing of unit shall be light weight powder coated galvanized steel.

2.9.4 High Wall Mounted Indoor Units

The units shall be wall-mounted type. The unit includes pre filter, fan section & DX coil section. The housing of unit shall be light weight powder coated galvanized steel.

Unit shall have an attractive external casing for supply and return air.

2.9.5 Floor Standing Indoor Type

Unit shall be suitable for floor standing arrangement. The unit include pre filter, fan section & DX coil section. The housing of unit shall be light weight powder coated galvanized steel.

2.9.6 Centralized Type Remote Controller

A multifunctional compact centralized touch screen type controller shall be provided with the system. The Graphic Controller must act as an advanced air-conditioning management system to give complete control of VRV air-conditioning Equipment, It should have ease of use for the user through its touch screen, icon display and colour LCD display.

It shall be able to control up to 64 groups of indoor units with the following functions: -

a) Starting/stopping of Air-conditioners as a zone or group or individual unit.
b) Temperature settling for each indoor unit or zone.
c) Switching between temperature control modes, switching of fan speed and direction of airflow, enabling/disabling of individual remote controller operation.
d) Monitoring of operation status such as operation mode & temperature setting of individual indoor units, maintenance information, trouble shooting information.
e) Display of air conditioner operation history.
f) Daily management automation through yearly schedule function with possibility of various schedules.

The controller shall have wide screen user friendly color LCD display and can be wired by a non polar 2 wire transmission cable to a distance of 1 km. away from indoor unit.

3.1 AIR COOLED PACKAGED AND SPLIT AIR CONDITIONING UNITS 3.1 SCOPE

The scope of this section comprise the supply, erection, testing and commissioning of Air Cooled Packaged and Split Units conforming to these specifications and in accordance with the requirements of Drawings and Schedule of Quantities.

3.2 TYPE

The Split Units shall consist of hermetically sealed reciprocating / Scroll compressor, motor, air cooled condenser, strip heaters, integral refrigerant piping and wiring, all mounted on a steel frame.

Indoor unit to be installed for Split Unit within building, shall be housed in insulated cabinet consisting of cooling coil, blower with motor, filter & insulated drain pan.

The Air Cooled Packaged Unit shall consist of hermetically sealed reciprocating / Scroll compressor, motor, strip heaters, integral refrigerant piping and control panel duly wired to compressor and air cooled condenser all mounted on a steel frame. The Air cooled condenser with fan duly mounted on a common frame shall be installed on the wall openings with suitable angle iron / channel frame to be provided by contractor. The suitable starters, switches, power control cabling between Air Cooled Packaged Unit and Air Cooled Condenser shall be included by the contractor.

3.3 CAPACITY

The refrigeration capacity of Packaged Unit and Room Air Conditioners, split unit shall be as shown on drawings and in Schedule of Quantities.

3.4 COMPRESSOR AND MOTOR

Compressor shall be hermetic reciprocating / Scroll, serviceable type and shall have dual pressure stat, and an operating oil charge. The motor shall be suction gas cooled and shall be sealed against dirt and moisture. The motor shall be suitable for 415±10% / volts or 230±6 % volts, 50 Hz, A. c. supply.

3.5 REFRIGERANT PIPING AND CONTROLS

Refrigerant piping and fittings interconnecting compressor condenser shall be all copper and valves shall be brass / gunmetal construction.

3.6 CASING

The indoor & outdoor units shall be sectionalized / cabinet construction. Indoor units shall be consisting of fan section, coil section, filter section, and drain pan. Outdoor unit shall consist of condenser coil, fan & compressor. In case of package units, the compressor shall be mounted within the indoor units and in case of split unit, the compressor shall be mounted with the outdoor units. Each section shall be constructed of thick sheet steel all welded / bolted construction, adequately reinforced with structural members and provided with sufficient access panels for proper lubrication and maintenance. Base panel shall be constructed of fabricated steel structure provided with an under frame suitably braced. Each unit shall include one piece drain pan constructed of 20 gauge galvanized sheet steel plate. Drain pan shall extend under coil and fan sections with drain connections. Removable panels in fan and coil sections shall provide access to all internal parts. Panels shall be internally lined with 2.5 cm thick fiber glass as per section "Insulation" for the thermal insulation and acoustic lining.

3.7 FAN MOTOR AND DRIVE

Fan motor shall be suitable for 415 ± 10% volts or 230±10% volts, 50 Hz, A. c. Supply, Single phase, motors shall be provided with permanent capacitor. Motors shall be especially designed for quite operation and motor speed shall not exceed 1440 rpm.

3.8 FAN

Fan wheels and housing shall be fabricated from heavy gauge steel. Fan wheels shall be of double- width, double inlet forward-curve, multi-blade type enclosed in a housing and mounted on a common shaft. Fan housing shall be made of die-formed steel sheets with stream-lined inlets to ensure smooth air flow into the fans, fan shaft bearing shall be oil/grease lubricated. All rotating parts shall be dynamically balanced individually, and the complete assembly shall be statically and hydraulically balanced. Fan speed shall not exceed 1000 rpm and maximum fan outlet velocity shall be 550 meters per minute.

3.9 COOLING COIL

Cooling coils shall be of fin and tube type having aluminum fins firmly bonded to copper tubes assembled in zinc coated steel frame. Face and surface areas shall be such as to ensure rated capacity from each unit and air velocity across each coil shall not exceed 100 meters per minute. The coil shall be pitched in the unit casing for proper drainage. Each coil shall be factory-tested at 21 Kg. per sq. cm air pressure under water. Tube shall be mechanically / hydraulically expanded for minimum thermal contract resistance with fins. The number of fins per cm. shall be 4 to 5.

3.10 VIBRATION ISOLATORS

The indoor and outdoor units shall be provided with ribbed rubber pad vibration isolators.

3.11 PAINTING

Split units shall be factory finished with durable alkyd spray enamel. Shop coats of paint that have become marred during shipment or erection shall be cleaned off with mineral spirits, then coated with enamel paint to match the finish over the adjoining shop-painted surface.

3.12 PERFORMANCE RATING

The unit shall be selected for the lowest operating noise level. Capacity rating and power consumption with operating points clearly indicated shall be submitted for approval before start of work and verified at the time of testing and commissioning of the installation.

4 FANS

4.1 SCOPE

The scope of this section comprises the supply, erection, testing and commissioning of centrifugal, in-line and propeller type fans and roof mounted units conforming to these Specifications and in accordance with the requirement of Drawings and Schedule of Quantities.

4.2 TYPE

Centrifugal, in-line propeller fans and roof mounted units shall be of the type as indicated on Drawings and identified in Schedule of Quantities.

4.3 CAPACITY

The air-moving capacity of fans shall be as shown on Drawings and in Schedule of Quantities.

4.4 AXIAL FLOW FAN

Fan shall be complete with motor, motor mount, belt driven (or direct driven) and vibration isolation type, suspension arrangement as per approved for construction shop drawings.

a) Casing: shall be constructed of heavy gauge sheet steel. Fan casing, motor mount and straightening vane shall be of welded steel construction. Motor mounting plate shall be minimum5 mm thick and machined to receive motor flange.

   An inspection door with handle and neoprene gasket shall be provided. Casing shall have flanged connection on both ends for ducted applications. Support brackets for ceiling suspension shall be welded to the casing for connection to hanger bolts. Straightening vanes shall be aerodynamically designed for maximum efficiency by converting velocity pressure to static pressure potential and minimizing turbulence. Casing shall be bonderized, primed and finish coated with enamel paint.

b) Rotor : Huband blades shall be cast aluminum or cast steel construction. Blades shall be die- formed aerofoil shaped for maximum efficiency and shall vary in twist and width from hub to tip to effect equal air distribution along the blade length. Fan blades mounting on the hub shall be statically and dynamically balanced. Extended grease leads for external lubrication shall be provided. The fan pitch control may be manually readjusted at site upon installation, for obtaining actual air flow values, as specified and quoted.

c) Motor: shall be energy efficient squirrel-cage, totally- enclosed, fan cooled, standard frame, constant speed, continuous duty, single winding, suitable for415±10% volts, 50 cycles, 3 phase AC power supply, provided with class `F' insulation. Motor shall be specially designed for quiet operation. The speed of the fans shall not exceed 1000 RPM for fans with impeller diameter above 450 mm, and 1440 RPM for fans with impeller diameter 450 mm and less. For lowest sound level, fan shall be selected for maximum efficiency or minimum horsepower. Motor conduit box shall be mounted on exterior of fan casing, and lead wires from the motor to the conduit box shall be protected from the air stream by enclosing in a flexible metal conduit.

HP	POWER FACTOR			EFFICIENCY		
	FL	3/4L	1/2L	FL	3/4L	1/2L
0.50	0.71	0.62	0.50	73.00	73.00	68.00
0.75	0.74	0.64	0.50	78.00	78.00	70.00
1.00	0.76	0.67	0.55	82.50	82.50	77.00
1.50	0.77	0.70	0.57	83.80	83.80	80.00
2.00	0.77	0.70	0.57	85.00	85.00	81.00
3.00	0.82	0.74	0.60	86.40	86.40	84.00
5.00	0.82	0.78	0.63	88.30	88.30	86.00

7.50	0.85	0.80	0.71	89.50	88.50	88.00
10.0	0.86	0.83	0.76	90.30	90.30	89.00
12.5	0.84	0.82	0.73	90.50	90.50	88.00
15.0	0.85	0.83	0.76	91.50	91.50	89.50
20.0	0.85	0.83	0.76	92.20	92.20	91.00
25.0	0.85	0.82	0.76	92.40	92.40	91.00
30.0	0.85	0.80	0.72	92.80	92.80	92.00
40.0	0.86	0.85	0.80	93.20	93.20	91.00
50.0	0.87	0.85	0.77	93.60	93.60	91.60
60.0	0.88	0.86	0.78	93.90	93.90	91.90
75.0	0.87	0.85	0.78	94.20	94.20	92.80

d) Drive: to fan shall be provided through belt drive with adjustable motor sheave and standard sheet steel belt guard with vented front for heat dissipation. Belts shall be of oil-resistant type.

e) Vibration Isolation : The assembly of fan and motor shall be suspended from the slab by vibration isolation suspension of heavy duty spring isolators type.

f) Accessories : The following accessories shall be provided with all fans :

I. Outlet cone for static pressure regain.
II. Inlet cone.

Fan silencers may be provided where specifically called for in Schedule of Quantities. Fans shall be factory assembled and shipped with all accessories factory-mounted.

4.5 PROPELLER FAN

Propeller fan shall be direct-driven, three or four blade type, mounted on a steel mounting plate with orifice ring.

a) Mounting Plate shall be of steel construction, square with streamlined venture inlet (reversed for supply applications) coated with baked enamel paint. Mounting plate shall be of standard size, constructed of 12 to 16 gauge sheet steel depending upon the fan size. Orifice ring shall be correctly formed by spinning or stamping to provide easy passage of air without turbulence and to direct the air stream.

b) Fan Blades shall be constructed of aluminum or steel. Fan hub shall be of heavy welded steel construction with blades bolted to the hub. Fan blades and hub assembly shall be statically and dynamically balanced at the manufacturer's works.

c) Shaft shall be of steel, accurately ground and shall be of ample size for the load transmitted and shall not pass through first critical speed thru the full range of specified fan speeds.

d) Motor shall be standard (easily replaceable) permanent split capacitor or shaded pole for small sizes, totally enclosed with pre-lubricated sleeve or ball bearings, designed for quiet operation with a maximum speed of 1000 rpm for fans 60 cm dia or larger and 1440 rpm for fans 45 cm dia and smaller. Motors for larger fans shall be suitable for 415 ± 6% volts, 50 cycles 3 phase power supply, and for smaller fans shall be suitable for 220 ± 6% volts, 50 cycles single phase power supply. Motors shall be suitable for either horizontal or vertical service as indicated on Drawings and in Schedule of Quantities.

e) Accessories: The following accessories shall be provided with propeller fans:

I. Wire guard on inlet side and bird screen at the outlet.
II. Fixed or gravity louvers built into a steel frame at the outlet.
III. Regulator for controlling fan speed for single phase fan motor.
IV. Single phase preventers for 3 phase fans.

4.6 PERFORMANCE DATA

All fans shall be selected for the lowest operating noise level. Capacity ratings, power consumption, with operating points clearly indicated, shall be submitted and verified at the time of testing and commissioning of the installation.

4.7 TESTING

Capacity of all fans shall be measured by an anemometer. Measured air flow capacities shall conform to the specified capacities and quoted ratings. Power consumption shall be computed from measurements of incoming voltage and input current.

5.0 PIPING

5.1 SCOPE

The scope of this section comprises the supply and laying of pipes, pipe fittings and valves, testing and balancing of all condensate and refrigerant piping required for the complete installation as shown on the Drawings. All piping inclusive of fittings and valves shall follow the applicable Indian Standards.

5.2 PIPE SIZES

Pipe sizes shall be as required for the individual fluid flows. Various pipe sizes have been indicated on the Drawings, these are for Contractor's guidance only and shall not relieve contractor of responsibility for providing smooth noiseless balanced circulation of fluids.

5.3 DRAIN PIPING

a) The piping system shall consist of Non-pressure pipe up to 4 kg/ sq.mm UPVC piping from 15 mm to 50 mm.
b) For any internal works, the UPVC pipes and fittings shall be embedded in the wall chase or run on the floor/ceiling unless otherwise specified. No unsightly exposed runs shall be permitted.
c) For proper drainage of Condensate, 'U' trap shall be provided in the drain piping.
d) All condensate drain piping shall be insulated and painted as per the section "Insulation" as indicated in Schedule of Quantities.

5.4 REFRIGERANT PIPING

I. All refrigerant pipes and fittings shall be hard drawn copper tube sand wrought copper / brass fittings suitable for connection with silver solder / phos-copper.

II. All joints in copper piping shall be sweat joints using low temperature brazing and / or silver solder. Before joining any copper pipe or fittings, its interiors shall be thoroughly cleaned by passing a clean cloth via wire or cable through its entire length. The piping shall be continuously kept clean of dirt etc. while constructing the joints. Subsequently, it shall be thoroughly blown out using carbon dioxide / nitrogen.

III. Refrigerant lines shall be sized to limit pressure drop between the evaporator and condensing unit to less than0.2 kg per sq.cm.

IV. Sight glass with moisture indicator and removable type combination dryer cum filter with MS housing and brass wire mesh / punched brass sheet shall be installed in liquid line of the refrigeration system incorporating a three valve by pass. After ninety days of operation, liquid line drier cartridges shall be replaced.

V. Heat exchanger shall be MS heavy duty pipe in pipe type and without any joint in the inner pipe.

VI. Horizontal suction line shall be pitched towards the compressor and no reducers shall be provided for proper oil return.

VII. After the refrigerant piping installation has been completed, the refrigerant piping system shall be pressure tested using Freon mixed with nitrogen/ carbon dioxide at a pressure of 20 kg per sq. cm (high side) and 10 kg per sq. cm (low side). Pressure shall be maintained in the system for a minimum of 12 hours. The system shall then be evacuated to a minimum vacuum of 70 cm of mercury and held for 24 hours. Vacuum shall be checked with a vacuum gage.

VIII. All refrigeration piping shall be installed strictly as per the instructions and recommendations of air-conditioning equipment manufacturer.

6 CHILLER SYSTEM

6.1 Chilling unit (Water cooled only)

Full load test shall be carried out to verify the capacity and 1KW / Ton. (For air-cooled chilling units this test shall be carried out at site).

Note: - In case of imported centrifugal chilling machine, initial inspection shall be carried out at site before installation in respects of items needing physical inspection and verification. No tests shall be done at manufacturer's works. The test certificates for all the specified tests shall be produced which shall be accepted if found in order.

6.2 Air Handling Units

a) Salient features such as model, size, physical dimensions, and other details of various sections, fan motor details, fan diameter, static pressure etc. shall be verified against the contract requirements.
b) Manufacturers internal test certificates for the motor and air-handling unit shall be furnished and scrutinized as per the contract requirements.
c) Test certificate for static dynamic balancing of the fan / blower should be furnished. Fan balancing may be witnessed by Engineer-in-Charge or his authorized representative.
d) Salient features like, type, material, and no and of gauge and fins and tubes and no of cooling coil shall be furnished and verified with reference to contract requirements during stage inspection.
e) Hydraulic pressure to the extent of 10 Kgf / sq.cm or pneumatic pressure of 21 Kgf / sq.cm shall be applied to cooling coil and this pressure should be maintained for 1 hour and no drop should be observed indicating and leaks.

7 PROFORMA FOR TEST RESULTS & NOTES ON TEST INSTRUMENTS AND CAPACITY COMPUTATIONS

S.No.	Item	Test	Results
1	Ambient Conditions	D.B. Temp. W.B. Temp. % RH	- ^{0}C - ^{0}C
2	Compressors	R.P.M. Suction pressure Discharge pressure Oil pressure	 - kg/sq.cm - kg/sq.cm - kg/sq.cm
3	Compressors Motors	R.P.M. Voltage Current At 100% load At partial load 80% 60% 50% 30%	 - Volts - Amps - - Amps - Amps - Amps - Amps
4	Water Chillers	Water flow rate Water temperature Entering Leaving Water pressure Entering Leaving	- LPM - ^{0}C - ^{0}C - kg/sq.cm - kg/sq.cm
5	Condensers	Water flow rate Water temperature Entering Leaving Water pressure Entering Leaving	- LPM - ^{0}C - ^{0}C - kg/sq.cm - kg/sq.cm
6	Pumps	R.P.M. Motor current Discharge pressure Suction pressure	 - Amps - kg/sq.cm - kg/sq.cm
7	Cooling Towers	Water temperature Entering Leaving Wet bulb approach Fan motor current Fan motor voltage Fan motor R.P.M.	 - ^{0}C - ^{0}C - ^{0}C - Amps - Volts
8	Air Handling Unit	Total air quantity across coil Coil face area Air temperature Entering (D.B.) Entering (W.B.) Leaving (D.B.) Leaving (W.B.) Water pressure Entering Leaving	- Cu.m / min Sq.m - ^{0}C - ^{0}C - ^{0}C - ^{0}C - Kg/sq.m - Kg/sq.m

S.No.	Item	Test	Results
		Water temperature Entering Leaving Water flow rate	 - ^{0}C - ^{0}C LPM
9	Fresh air intakes	Face area Air quantity	- Sq.m - Cu.m/min
	Room condition at working plane (No. of reading shall be taken and averaged out)	Temprature D.B W.B	 -°C -°C
10	Controls	Function of each control shall be tested and report furnished.	

Notes: -

A) TEST INSTRUMENTS

1) All instruments for testing shall be provided by the air-conditioning contractor.
2) Thermostat used for measurement of temperature of water / refrigerant shall have graduation of 0.1^{0}C and shall be got calibrated from N.P.L or any recognized test house before hand.
3) Thermometers used in the psychometer shall have graduations of 0.2^{0}C and shall be calibrated as at (2) above.
4) Pressure gauges shall also be got calibrated before hand from a recognized test house.
5) Orifice type of flow meters shall be used for measuring flow rate through the condensers and chillers.

B) CAPACITY COMPUTATIONS

1) Condensing unit: - The capacity shall be computed from the water temperatures and water flow rate measurements of the condenser water and the compressor motor current readings. A reference may be made, if necessary to the manufacturer's motor performance characteristic for arriving at the B.H.P consumption.

2) Water chilling unit: - The capacity shall be computed from the water temperature and water flow rate measurements of the chiller. Heat rejection from the condenser shall be computed from the water temperature and water flow rate measurements at the condenser.

3) Cooling Tower: - Water quantity measured at the condenser and the temperature of water at the cooling tower shall be recorded. Wet bulb approach shall be checked against design data recorded in the tender documents.

4) Air Handling units (Chilled water type): - The capacity shall be computed from the water temperature and water flow rate measurements. A tolerance of $\pm$ 5% from the tender documents value shall be acceptable in the capacity computed. Air quantity shall be measured in the supply duct and checked with quantity specified in the tender documents. A tolerance of $\pm$ 10% in the air quantity shall be acceptable. The enthalpy difference of air entering and leaving the coil shall be computed from air temperature and recorded.

5) Air Handling Unit (DX Type): - The capacity shall be computed from the air quantity measured in the supply air duct and the enthalpy difference between the air entering and leaving coil. Air quantity measured shall be checked with that recorded in the tender documents. A tolerance of $\pm$ 10% from the tender documents value shall be acceptable.

6) For the purpose of system capacity, the refrigerant tonnage obtained from the main refrigeration plant will be accepted.

7) If due to any reason, internal load mentioned in the tender specifications is not available psychometric computations for actual load conditions will be done and the plant, if found satisfactory will be accepted.

a. The equipment capacity computations as per above Para B under notes of **"CAPACITY COMPUTATION"** shall be carried out.
b. The input KW of the unit / TR at full load shall also be checked against contract requirements, if any.
c. Pressure drop across chiller and condenser at specified flow rate shall be checked against the contract requirements.
d. All instruments for testing shall be provided by the AC contractors. These shall be as per above not **A "Test Instruments".** The accuracy of the instrument shall be as follows:

- Temperature: Liquid in glass thermometer having accuracy $\pm$ 1^{0}C as per IS:4825.
- Wet bulb temperature: Sling psychometer conforming to IS:6017.
  Scale Error : For less than 0^{0}C - 0.3^{0}C $\pm$ 2.2^{0}C

For over 0^0C - 0.2^{0}C $\pm$ 0.1^{0}C

- Pressure Gauge: With the accuracy of $\pm$ 1% for maximum scale value from 10 to 90%, and $\pm$ 1.9% for maximum scale value for rest of the scale conforming to IS:3695.
- Water flow meter: Water flow shall be measured using the arrangement installed as per schedule of work.
- In case the tendering firms do not have testing instruments of the accuracy mentioned above, they should specify the accuracy of the instruments available with them for testing at the tender stage.

7.1 TESTING REQUIREMENTS AND PROCEDURES

7.1.1 Balancing of all air and water systems and all tests as called foe in the specification shall be carried out by the HVAC contractor in accordance with the specifications and relevant local codes if any. Performance tests of individual equipment and control shall be carried as per manufactures recommendation. All tests and balancing shall be carried out in the presence of Engineer-in-Charge or his authorized representative.

The whole system balancing shall be tested with microprocessor based hi-tech instruments with an accuracy $\pm$ 0.5%.

The instruments shall be capable of storing data and then down loading in to a P.C. the HVAC contractor shall provide a minimum but not limited to the following instruments:

- Microprocessor based calculation matter to measure DB and WB temperature, RH and Dew Point.
- Velometer to measure air volume and air velocity.
- Pitot tube.
- Electronic rotary vane anemometer.
- Accubalance flow measuring hood.

The contractor shall be responsible to provide necessary sockets and connections for fixing of the testing instruments, probes etc.

7.1.2 **Air Systems:** Systems are to be balanced by first adjusting the total flow at the fan, then by adjusting main dampers and branch dampers. Only final minor adjustments are to be made with register and diffusers dampers. Balancing of the air system shall be accomplished without causing objectionable air noise. Baffles and orifice plates required for proper air balanced shall be furnished and installed by the contractor. Basically the following tests and adjustments are required.

a) Test all fan systems to provide proper cfm. / cmh.
b) Adjust fresh air, return air and exhaust dampers to provide proper air quantities in all models of control.
c) Test and record fresh air, return air and mixed air temperature at all air handling units. Test and record data at all coils after air and hydraulic systems are balanced. Measures wet and dry bulb temperature on cooling coils.
d) Make point tube transverse at all main supply and return ducts to set proper air quantities. Adjust all zone and branch dampers to proper cfm. / cmh.
e) Test and adjust each register, grills, diffuser or other terminals equipments to within 5% of design air quantity. Each opening shall be defined on the test report by size, manufacturer's model, room location, design cfm. and actual cfm. Outlets shall be adjusted to minimize objectionable drafts.
f) Test and record static pressure drop across all filters and major coils.
g) High velocity duct systems shall be tested for leakage. If excessive or audible leakage is detected, the defect shall be repaired by the contractor. Sufficient static pressure readings shall be taken from the air-handling units to the terminal units establish system static pressure.

7.1.3 **Water System:** Systems are to be balanced by opening all valves, closing all by-pass and setting all mixing valves to full coil flow. Water systems shall be cleared of air. Verify that the system has been properly cleaned, flushed and treated before testing. Basically, the following tests and adjustments are required.

I. Test and adjust all pumps to deliver the proper gpm. record rpm, motor amperage, discharge and suction pressure. Pumps shall without objectionable noise or cavitations. Plot actual and system performance points on manufacturers pump curves.
II. Check all expansion tanks for proper filling pressurization. Verify operation of automatic fill and relief valves.
III. Check the operation of all automatic valves.

IV. Test and adjust correct water through chiller, major items of equipment and main water circuits. The balancing valves, provided on the equipment shall be used for adjustment.
V. Check capacity output of chillers and set water flow rate for proper data.
VI. Check and adjust each coil to provide gpm. record water and air temperature charge and water pressure drop.
VII. Set pressure drops coil by-pass to match coil full-flow pressure drop.

7.1.4 Unit capacity in Tons Refrigeration shall be competed from the temperature readings, pressure readings and water/ brine flow measurements. Flow measurements shall be preferably through flow meters. Pumps shall be tested for the discharge head, flow and BHP. Where it is not possible to measure the flow, at least the discharge head and BHP, (on the input side) shall be field-tested.

7.1.5 Balancing Tolerance

Systems shall be balanced within the following tolerance:

1) Duct leakage Rates (at operating pressures)

Low pressure ducts (0 to 0.5 kpa)	5% of full flow
Medium pressure ducts (0.5 to 3 kpa)	1% of full flow
High pressure ducts (Greater than 3 kpa)	1% of full flow

2) **Air flow rates**

Under 70 L/S	10% of flow
Over / at 70 L/S	5% of flow

3) Water flow rates

Chilled water	2% of flow
Other	5% of flow

4) **Heat flow rates**

Heat exchangers	5% of design capacity

Procedure

Review all pertinent plans, specifications, shop drawings and other documentation to become fully familiar with the systems and their specified and intended performance.

Furnish equipment and instruct sheet metal trade on proper use for conducting duct leakage tests. Conduct first test as a way of instructing the above trades in the presence of the Departments representative.

Test relative barometric pressures in various building area, as deemed necessary by the department's representatives and at least in all areas served by different systems.

Test performance and continuously record on a 24 hours, temperature and humidity levels where control equipment is provided for that purpose in certain critical areas.

Before commissioning of the equipment, the entire electrical installation shall be tested in accordance with relevant BIS codes and test report shall be furnished by a qualified and authorized person.

7.1.6 Reports

Provide 3 copies of the complete balancing and testing reports to the department. Report shall be neatly typed and bound suitable for a permanent record. Report forms shall contain complete test data and equipment data as specified and safety measures provided as all equipment's shall incorporate suitable provisions to ensure safety of the operating personnel at all times. The initial and final inspection reports shall bring out explicitly the safety provisions incorporated in each equipment.

7.2 COMPLIANCE WITH REGULATIONS AND INDIAN STANDARDS, INDEMNITY & INSURANCE

All works shall be carried out in accordance with relevant regulation, both statutory and those specified by the Indian standards as detailed below:

A) Conformity with statutory acts, rules, standards and codes

a. All components shall conform to relevant Indian Standard Specifications, wherever existing, amended to date. A list of such standards is appended in the last of the tender.

b. All electrical works shall be carried out in accordance with the provisions of Indian Electricity Act, 2003 and Indian Electricity Rules, 1956 amended to date. They shall also conform to CPWD General Specifications for Electrical works; Internal, External and Sub-station amended to date.

B) Safety codes and labour regulations

(i) All the safety procedures outlined in the codes listed in the last appendix of the tender shall be complied with.

(ii) In respect of all labour employed directly or indirectly on the work for the performance of the air conditioning contractor's part of work, the contractor at his own expense will arrange for the safety provisions as per the statutory, BIS recommendations, factory act, workman's completion act, and instructions issued from time to time. Failure to provide such safety requirements would make the tenderer liable for penalty for Rs.200/- for each violation. In addition the Engineer-in-charge shall be at liberty to make arrangements and provide facilities as aforesaid and recover the cost from the contractor.

(iii) The contractor shall provide necessary barriers, warning signals and other safety measures while laying pipelines, ducts cables etc. or wherever necessary so as to avoid accident. He shall also indemnify against claims for compensation arising out of negligence in this respect. Contractor shall be liable, in accordance with the Indian Law and regulations for any accident occurring due to any cause. The department neither shall nor be responsible for any accident occurred or damage incurred or claims arising there from during the execution of work. The contractor shall also provide all insurance including third party insurance as may be necessary to cover the risk. No extra payment would be made to the contractor due to the above provisions thereof.

C) Works to be arranged by the Department

None of the works are to be done by the Owner. The contractor is expected to create fronts in a manner that the HVAC works are completed as per the defined milestones.

D) Works to be done by the contractor

Unless otherwise mentioned in the tender documents, the following works shall be done by the contractor and therefore, their cost shall be deemed to be included in their tendered cost-whether specifically indicated in the schedule of work or not: -

I. Foundations for equipments including foundation bolts and vibration isolation spring / pads.
II. Support columns and beams for cooling towers.
III. Suspenders, brackets and floor / wall supports for suspending / supporting ducts and pipes.
IV. Suspenders and / or cable trays for laying the cables.
V. Excavation and refilling of trenches in soil wherever the pipes are to be laid directly in ground, including necessary base treatment and supports.
VI. Sealing of all floor slab / wall opening provided by the department or contractor for pipes and cables, from fire safety point of view, after lying of the same.
VII. Painting of all exposed metal surface of equipments and components with appropriate colour as per Cl. No. 7.3 **"COLOUR SCHEME: THE EQUIPMENTS AND COMPONENTS'.**
VIII. Making opening in the walls / floors / slabs or modification in the existing openings wherever provided for carrying pipeline, ducts cables etc.
IX. Providing wooden / metallic frames for fixing grills / diffusers.
X. Under deck insulation of top floor slab, if top floor is air-conditioned and if specified in schedule of work.
XI. Making good all damages caused to the structure during installation and restoring the same to their original finish.

7.3 COLOUR SCHEME: THE EQUIPMENTS ANDS COMPONENTS

A) Colour scheme for equipment like chilling unit, pumps, AHUs, cooling tower etc. shall be as per manufactures standard colour scheme.

B) The scheme of colour code painting of pipe work services for air conditioning installation shall be as per national building code and is indicated below: -

Description	**Ground Colour**	**Lettering Colour**	**First Colour Band**
Condenser water piping	Sea Green	Black	French Blue
Chilled water piping	Sea Green	Black	Black
Central heating piping below 60 ^{0}C	Sea Green	Black	Canary Yellow
Central heating piping 60 ^{0}C to 100 ^{0}C	Sea Green	Black	Dark Violet
Drain Pipe	Black	White	
Vents	White	Black	
Valves and pipe line fittings	White with black handles	Black	
Belt Guard	Black & Yellow diagonal strips		
Machine Bases, inertia bases and plinth	Charcoal Grey		

C) Colour bands shall be 150mm wide, superimposed on ground colour to distinguish type and condition of fluids. The spacing of band shall not exceed 4.0m.

D) In addition to the colour bands specified above all pipe work shall be legibly marked with black or white letters to indicate the type of service and the direction of flow identified as follows:

High temperature hot water	:	HTHW
Medium temperature hot water	:	MTHW
Low temperature hot water	:	LTHW
Chilled water	:	CHW
Condenser water	:	CDW
Steam	:	ST
Condensate	:	C

7.4 AFTER SALES SERVICES

The contractor shall ensure adequate and prompt after sales services in the form of maintenance, spares and personnel as and when required and shall minimize the breakdown period. In case of equipment supplied by other manufacturers the firm shall furnish a guarantee from the manufacturer for the same before the plant is taken over.

8 AIR DISTRIBUTION

8.1 SCOPE

The scope of this section comprises supply fabrication, installation and testing of all sheet metal / aluminium ducts, supply, installation, testing and balancing of all grilles, registers and diffusers. All to be in accordance with these specifications and the general arrangement shown on the Drawings.

8.2 DUCT MATERIALS

8.2.1 Raw Materials

Galvanizing shall be Class VII – light coating of zinc, nominal 180gm/sq.m surface area and Lock Forming Quality prime material along with mill test certificates. In addition, if deemed necessary, samples of raw material, selected at random by owner's site representative shall be subject to approval and tested for thickness and zinc coating at contractor's expense.

8.2.2 Gauges, Bracing By Size of Ducts

All ducts shall be fabricated from galvanized steel / aluminum of the following thickness, as indicated as below:

8.3 FABRICATION STANDARDS & EQUIPMENT

All duct construction and installation shall be in accordance with SMACNA standards. In addition ducts shall be factory fabricated utilizing the following machines to provide the requisite quality of ducts.

a) Coil (Sheet metal in Roll Form) lines to facilitate location of longitudinal seams at corners/folded edges only, for required duct rigidity and leakage free characteristics. No longitudinal seams permitted along any face side of the duct.
b) All ducts, transformation pieces and fittings to be made on CNC profile cutter for requisite accuracy of dimensions, location and dimensions of notches at the folding lines.
c) All edges to be machine treated using lock formers, flangers and rollers for turning up edges.
d) Kitchen exhaust ducting shall be with 16 G MS. Suitable access doors shall be provided at every 3m. Provision shall be made for firefighting agency to install duct mounted sprinklers at every 3m. Generally exhaust ducts shall have slope towards kitchen hood.

8.4 DUCT CONSTRUCTION

All ducts shall be fabricated and installed in workmanlike manner, conforming to relevant SMACNA codes.

a) Ducts so identified on the Drawings shall be acoustically lined and insulated from outside as described in the section "Insulation" and as indicated in Schedule of Quantities. Duct dimensions shown on drawings, are overall sheet metal dimensions inclusive of the acoustic lining where required and indicated in Schedule of quantities. The fabricated duct dimensions should be as per approved drawings and care should be taken to ensure that all connecting sections are dimensionally matched to avoid any gaps.
b) Ducts shall be straight and smooth on the inside with longitudinal seams shall be airtight and at corners only which shall be either Pittsburgh or snap button as per SMACNA practice, to ensure air tightness.
c) All ducts up to 75cms width within conditioned spaces shall have slip and drive (C & S/SS) joints. The internal ends of slip joints shall be in the direction of airflow. Care should be taken to ensure that S/SS Cleats are mounted on the longer side of the duct and Cleats on the shorter side. Ducts and accessories within ceiling spaces, visible from air-conditioned areas shall be provided with two coats of mat black finish paint.
d) Changes in dimensions and shape of ducts shall be gradual (between 1:4 and 1:7).Air-turns (vanes) shall be installed in all bends and duct collars designed to permit the air to make the turn without appreciable turbulence.
e) Ducts shall be fabricated as per details shown on Drawings. All ducts shall be rigid and shall be adequately supported and braced where required with standing seams, tees, or angles, of ample size to keep the ducts true to shape and to prevent buckling, vibration or breathing.
f) All sheet metal connection, partitions and plenums, required to confine the flow of air to and through the filters and fans, shall be constructed of 18 gauge GSS / 16gauge aluminum, thoroughly stiffened with 25mm x 25mm x 3mm galvanized steel angle braces and fitted with all necessary inspection doors as required, to give access to all parts of the apparatus. Access doors shall be not less than 45cm x 45cm in size.
g) Plenums shall be shop/factory fabricated panel type and assembled at site. Fixing of galvanized angle flanges on duct pieces shall be with rivets heads inside i.e. towards GS sheet and riveting shall be done from outside.
h) Self adhesive Neoprene rubber / UV resistant PVC foam lining 5mm nominal thickness instead of felt, shall be used between duct flanges and between duct supports in all ducting installation.

8.5 DAMPERS

a) Dampers :All duct dampers shall be opposed blade louver dampers of robust 16 G GSS construction and tight fitting. The design, method of handling and control shall be suitable for the location and service required.
b) Dampers shall be provided with suitable links levers and quadrants as required for their proper operation. Control or setting device shall be made robust, easily operable and accessible through suitable access door in the duct. Every damper shall have an indicating device clearly showing the damper position at all times.
c) Dampers shall be placed in ducts at every branch supply or return air duct connection, whether or not indicated on the Drawings, for the proper volume control and balancing of the air distribution system.

8.6 FIRE DAMPERS

a) Whenever a supply/return duct crosses from one fire zone to another, it shall be provided with approved fire damper of at least 1½ hour fire rating as per UL555/1995 tested by CBRI. This shall be curtain type fire damper.
b) Fire damper blades shall be one piece folded high strength 16 gage galvanized steel construction. In normal position, these blades shall be gathered and stacked at the frame head providing maximum air passage and preventing passing air currents from creating noise or chatter. The blades shall be held in position through fusible link of temp 70° C.
c) In case of fire, the intrinsic energy of the folded blades shall be utilized to close the opening. The thrust of the suddenly released tension shall instantly drive the blades down and keep it down without the use of springs, weights or other devices subject to failure.
d) Fire damper sleeves and access doors shall be provided within the duct in accordance with the manufacturer's recommendation.
e) The contractor shall also furnish to the Owner, the necessary additional fusible links (spares), as recommended by the manufacturer, at the time of commissioning of the installation.

8.7 SUPPLY AND RETURN AIR REGISTERS

Supply& return air registers shall be of either steel or aluminium sections as specified in schedule of quantities. Steel construction registers shall have primer Coat finish whereas extruded aluminium registers shall be either Anodized or Powder Coated as specified in Schedule of Quantities. These registers shall have individually adjustable louvers both horizontal and vertical. Supply air registers shall be provided with key operated opposed blade extruded aluminium volume control damper anodized in matt black shade.

The registers shall be suitable for fixing arrangement having concealed screws as approved by Architect. Linear continuous supply cum return air register shall be extruded aluminium construction with fixed horizontal bars at 15 Deg. inclination & flange on both sides only (none on top & bottom). The thickness of the fixed bar louvers shall be minimum 5.5 mm in front and 3.8mminrear with rounded edges. Flanges on the two sides shall be 20 mm/30 mm wide as approved by Architect. The grilles shall be suitable for concealed fixing. Volume control dampers of extruded aluminium anodized in black colour shall be provided in supply air duct collars. For fan coil units horizontal fixed bar grilles as described above shall be provided with flanges on four sides, and the core shall be& suitable for clip fixing, permitting its removal without disturbing the flanges.

a) All registers shall be selected in consultation with the Architect. Different spaces shall require horizontal or vertical face bars, and different width of margin frames. These shall be procured only after obtaining written approval from Architect for each type of register.
b) All registers shall have a soft continuous rubber/foam gasket between the periphery of the register and the surface on which it has to be mounted. The effective area of the registers for air flow shall not be less than 66percentof gross face area.
c) Registers specified with individually adjustable bars shall have adjustable pattern as each grille bar shall be pivot able to provide pattern with 0 to +45° horizontal arc and upto 30° deflection downwards. Bars shall hold deflection settings under all conditions of velocity and pressure.
d) Bar longer than 45 cm shall be reinforced by set-back vertical members of approved thickness.
e) All volume control dampers shall be anodized aluminium in mat black shade.

8.8 SUPPLY AND RETURN AIR DIFFUSERS

Supply and return air diffusers shall be as shown on the Drawings and indicated in Schedule of Quantities. Mild steel diffusers/dampers shall be factory coated with rust-resistant primer.

Aluminium diffusers shall be powder coated & made from extruded aluminium section as specified in schedule of quantities.

Rectangular Diffusers shall be steel / extruded aluminium construction,square & rectangular diffusers with flush fixed pattern for different spaces as per schedule of quantities these shall be selected in consultation with the Architect. These shall be procured only after obtaining written approval from Architect for each type of diffuser.

Supply air diffusers shall be equipped with fixed air distribution grids, removable key-operated volume control dampers, and anti-smudge rings as required in specific applications, and as per requirements of schedule of quantities. All extruded aluminium

diffusers shall be provided with removable central core and concealed key operation for volume control damper.

Linear Diffuser shall be extruded aluminium construction with removable core, one or two way blow type. Supply air diffusers shall be provided with volume control/ balancing dampers within the supply air collar. Diffusers for different spaces shall be selected in consultation with the Architect, and provided as per requirements of schedule of quantities. All diffusers shall have volume control dampers of extruded aluminium construction anodized in mat black shade.

Slot Diffuser shall be extruded aluminium construction multi slot type with air pattern controller provided in each slot. Supply air diffusers shall be provided with Hit & Miss volume control dampers in each slot of the supply air diffusers. Diffusers for different spaces shall be selected in consultation with the Architect and provided as per requirement of Schedule of Quantities.

ELEVATOR WORKS

1 GENERAL

1.1 SCOPE OF WORKS

The scope of work shall cover design, supply delivery, installation, testing and commissioning of elevators as described in the Schedule of Rates (SOR) and the SOR item shall also include the following:

a) Necessary scaffolding temporary barricade in the hoist way required during the erection of the elevators.
b) Minor building work comprising of cutting holes and making good, the car and counterweight rail brackets, hall buttons and indicators including laying of sills in position.
c) Steel items such as machine beams, bearing plates buffer support channels, sill angles and fascia plates etc.
d) Suitable trap doors with steel chequered plate covers.
e) Providing and installation of a suitable vertical iron ladder for access to the pit.
f) Any other item required for successful completion and commissioning of lifts (including the hoisting beam).

1.2 STANDARDS

The work shall be done in accordance with regulations of any local code and following ISI codes which govern the requirements of installations.

- IS: 1860-1980 Code of practice for installation, operation and maintenance of Electric Passenger and Goods Lifts.
- IS: 3534-1976 Outline dimensions of Electric Lifts.
- IS: 4666-1980 Specifications for Electric passenger and Goods Elevators.
- IS: 2365-1977 Specification for steel wire suspension ropes for lifts and hoists.
- IS: 4289-1984 Specification for lift cables.
- IS: 7759-1975 Specification for lift door locking device and contacts.
- IS: 3043-1987 Code of practice for earthing.
- IS: 1646-1997 Electrical installation for safety of building.
- IS: 2309-1989 Protections of building & structures against lighting.
- Indian Electricity Act 1910.
- Indian Electricity Rules, 1956.
- Delhi Lifts Rules, 1942.

1.3 SHOP DRAWINGS AND APPROVAL OF ELECTRICAL INSTALLATIONS

The selected bidder shall prepare a furnish shop drawings for approval by The Engineer in charge, such shop drawings shall be based on the Architectural drawings and requirements laid down in specifications, local laws and regulations etc.

The detailed drawings shall be submitted within one month of placement of order. The successful bidder shall obtain the approval of electrical Inspector and other local authorities as per requirements before submitting the drawings to Client/ Engineer. The contractor shall not proceed with installation work till the drawings are approved by the Engineer-in-Charge. Expenses incurred such as license fee etc. towards obtaining the approval of Electrical Inspector, local authority shall be reimbursed to the contractor as per actual on production of documentary proof. Approval of contractor's drawings shall not absolve the contractor of any of his obligations to meet the requirements of specification under this contract. Five sets of completion drawings, operation manual, maintenance manual, spare parts details shall be submitted to the Client/ Engineer in charge after completion of work.

1.4 GUARANTEE

The bidder shall guarantee the equipment against all defects of materials and workmanship for a period of one year from the date of commissioning of the equipment as certified by the owner. Any defects arising during the guarantee period shall be rectified and replaced by the bidder, at his own expense, to the satisfaction of the owner.

The warranty shall cover the following:

- Quality, strength and performance of the materials and equipment used.
- Safe electrical and mechanical stresses on all parts of the equipment under all specified conditions of operation.

- Satisfactory, performance during guarantee period including free replacement to be done in accordance with the maintenance instructions and schedules.
- Performance figures and other values as specified in schedule of guaranteed technical particulars.
- Prompt services during maintenance period for repairs and breakdowns.
- Attending to consequential damages to consignment of lift items supplied and installed due to defective workmanship, material designs etc., in any part from manufacturers work.
- There should not be more than 8 hours delay in attending to break downs/defects reported in station where the contractor has his service organization. At other places the contractor shall specify this service period along with his tender and this shall be strictly adhered to.

1.5 PERMITS, INSPECTION & LICENSE FEE

The contractor shall arrange all necessary local, provincial or national government permit and shall make arrangements for inspection and tests required thereby. All Expenses in this regard are to be borne by Bidder except the Statutory license fee which shall be reimbursed by the Owner on production of documentary evidence (in Original) for payment of the same.

1.6 ELECTRIC SUPPLY

3 phase, 415 Volts, 50 cycles A.C Electric supply shall be made available by the owner in machine room. The entire lift equipment should be suitable for operation and +10% to -20% of the rated supply voltage.

1.7 ELECTRICAL WIRING

The necessary A.C. supply of 3 Phase, 415 Volts 50 HZ shall be made available in the main control switch unit to be provided by the electrical contractor of owner in the machine room. All the electrical works beyond the main supply switch shall be carried out by the lift contractor i.e. supply and installations of panels for drive motors, switches and control complete with wiring as per system requirement and approval of the Engineer. The wiring shall be carried out strictly in accordance with Indian Electricity Rules and Indian code of Practice for Electrical Wiring Installation IS-732-1963 System Voltage not exceeding 650 V). For works not covered under any of the above wiring rules, the 13th edition of Electrical Engineers (Condense) shall apply. The cable and conduits to be used shall be of suitable size and grade conforming to relevant IS specification. Wiring for LT switch board to the motor terminal shall be with heavy duty 1.1 KV grade PVC insulated PVC sheathed, FRLS aluminium cable. All the trailing cables used for control and safety device shall conform to IS: 4289-1967, Specifications for lifts cables. The trailing cable circuits for controls, safety devices, lighting and signaling shall be separate and distinct. Power wiring between controller and main board to various landings shall be drawn in suitable size heavy gauge conduit stove enameled/painted conforming to I.S specifications. The Voltage and frequency of the supply shall be subjected to variations permissible under Indian Electricity Acts and Rules.

2 DRIVE MACHINERY

2.1 Lift Machine

The Lift machine will be gearless and shall be placed in the lift shaft. No machine room shall be provided. The gearless lift machine shall consist of a motor, traction sheave and brake drum/disc completely aligned on a single shaft. The gearless machine shall be A.C. gearless with the VVVF drive.

2.2 Sheaves

Sheaves and pulley shall be of hard alloy, cast iron, SG iron or steel and free from cracks, sand holes and other defects. They shall have machined rope grooves. The traction sheaves shall be grooved to produce proper traction and shall be of sufficient dimension to provide for wear in the groove. The deflector sheave shall be grooved so as to provide a smooth bed for the rope. The deflector or secondary sheave assemblies where used shall be mounted in proper alignment with the traction sheaves. such deflectors sheaves shall have grooves larger than rope diameter as specified in clause 8 of IS 14665 (Part -4 sec3) :2000 .The size of all the sheaves shall be in accordance with clause 8 .4 of IS 14665 (Part4-sec 3):2000.Wherever necessary suitable protective guards may be provided.

2.3 Shaft Keys

Shafts which support sheave, gears, coupling and other members which transmit torque shall be provided with tight fitting keys of sufficient strength and quality.

2.4 Brake

The lift drive machinery shall be provided with an electro-magnetic brake or motor operated brake normally applied by means of springs in compression when the operating device is in off position. The brake shall be suitably curved over the brake drum or brake disc and provided with fire proof friction lining. The operation of brake shall be smooth, gradual and with minimum noise .The brake shall be designed to be of sufficient size and strength to stop and hold the car at rest with rated load. The brake should be capable of operation automatically by the various safety devices, current failure and by the normal stopping of the car. The brake shall be released electrically. It shall also be possible to release the brake manually, such releases requiring the permanent application of manual forces so as to move the lift car in short stops. For this purpose suitable brake release equipment wherever necessary shall be supplied with each lift installation and the same shall be kept in safe custody to prevent misuse.

2.5 Hand winding wheel or handle

A suitable hand winding wheel or handle mounted on the end of motor shaft for manual operation to move the lift car up or down to bring it to nearest landing manually. The up or down direction of the movement of car should be clearly marked on the motor/ at suitable location. A warning plate written in bold signal red letters advising the maintenance staff to switch off the mains supply before releasing the brake and operating the wheel is to be prominently displayed.

2.6 Type of controls

Microprocessor based A.C Variable Voltage Variable Frequency Control shall be used. The design of the controller should be such that it can be mounted on a wall and is dust protected, providing sufficient protection against lizards, rodents, etc. Max. Permissible leveling inaccuracy shall be ±5 mm only. The VVVF controller shall have the following features:

a) Total control at all stages of the motion cycle
b) A consistent fully adjustable smooth ride
c) Better leveling accuracy under all condition
d) A higher power factor
e) Lower starting current
f) Energy saving through the reduced power consumption

The system should monitor critical aspects of system health, self help diagnostic capability as built in, control system to speed up trouble shooting. It shall have constant voltage transformer for trouble free operation.

2.7 VVVF Inverter Drive

Fully digital VF inverter incorporating Flux Vector Control, technique of Pulse Width Modulation (PWM) for directly controlling the current of the elevator motor and providing constant speed control over the entire frequency range under all conditions to achieve considerable power saving thereby reducing the overall power consumption reduction in generator capacity and improvement in power factor and high speed switching device – the IGBT (Insulated Gate Bipolar Transistor) embedded in the inverter for smooth and quite operation.

3 Installation Aspects

3.1 Installation of Lift Machine

Lift machine room will not be provided and the drive machinery, controller etc. of the Lift shall be installed in the lift shaft.
Equipment layout in lift shaft should allow proper access to the maintenance staff. Vibration Isolation arrangement shall be provided as required to prevent transmission of vibrations to the building and structure.
Provision of Lift shaft shall be as per requirement of lift vendor.

3.2 Guide Rails

The guide rails for lift car and counter weights shall be in accordance with clause 3 of IS 14665 (Part-4, section-2) 2000 .The Guide rails supported by brackets secured to hoist way at each floor shall be continuous throughout the entire travel and shall withstand without any deformation the action of safety care with a fully loaded car .

3.3 Guide Rails Shoes

To prevent car shaking automatic adjustable guide shoes should be used. The firm should use Teflon guide gibes on lubricated guide rails.

4 Lift Car

4.1 Car frame

The car frame shall be in accordance clause 4 of IS 14665 (Part-4, section-2) 2000 fabricated from formed or structural steel members shall be provided with adequate bracing to support the platform and car enclosures. The car safety shall be integral with car mounted on the bottom members of the car frame and shall be with flexible guide clamp type designed to stop and hold a fully loaded car and withstand without permanent deformation the operation of safety gears.

4.2 Car Platform

The car platform shall be of framed construction and designed on the basis of rated load evenly distributed confirming to IS 14665 (Part-1) 2000.
A load plate along with overload alarm, giving the rated load and permissible maximum number of passenger should be fitted in each lift car in a conspicuous position.

4.3 Car Body

The car shall be with glass panel at the rear side and enclosed on three sides by a metallic enclosure .The enclosure including the door shall withstand without deformation a thrust of 35 Kg applied normally at any point and as per IS 14665 (Part-4, section-3) 2001 and Ventilation openings as required.
Lift car door shall have a fire resistant rating of 1 hour.
The car roof shall be solid type capable of supporting a weight of at least 140 Kg and as per IS 14665 (Part-4, section-3) 2001

4.4 Operating Panels inside the car

The car operating panel shall be of metal, flush mounted and duly finished to match the car interior décor and shall contain all the devices as may be specified depending upon the type of operation required. In addition separate illuminated panel for indication the floor and direction may be provided on the top or the door way .All switches shall be fade proof and the devices shall be of suitable quality.
Each device and its operating position shall be legible fade proof and marked.

5 Lift Cables and Ropes

5.1 Buffers

The suitable heavy-duty spring buffers shall be placed below the car and counter weight arranged to sustain and shock, should the elevator over travel past the terminal limits. Buffer shall be designed for design speed + 15%. Clearance from under side of car resting on a fully compressed buffer shall not be less than 1.20M.

5.2 Ropes

These will be self-lubricated and manufactured from high grade steel and material special flexible and the combine breaking strength will be calculated with a minimum factor of safety of 10 times the combined weight of car with full load.

5.3 Travelling Cables

All wiring and electrical interconnections shall comply with governing codes. Insulated wiring shall have flame retardant and moisture proof outer covering and shall run in metal conduit tubing or approved electrical raceways. Traveling cables shall be flexible and suspended to relieve strain on individual conductors. A minimum of 10% spare conductors shall be provided in traveling cable.

5.4 Threshold

The threshold to be provided should be aluminum grooved, with self-supporting sill angle.

5.5 Hall buttons

For passenger and freight elevators, these shall be provided at each terminal landing. A single micro movement push button shall be provided at top most and landing floors, two micro movement buttons on a single plate shall be provided at each intermediate floor. When a hall call is registered by momentary pressure on a landing button, that button shall become illuminated until the call is answered.

Passenger and freight elevators call buttons shall be as per manufacturers' standard selection. The catalogues of the buttons offered shall be submitted along with the tender.

5.6 Motor

The make and type of hoisting motors and capacity should be mentioned. The motor should be suitable for elevator service (S4 duty) with high starting torque and starting current should be mentioned.
The motor shall be class F insulation and one (1) hour rated squirrel cage induction type having high starting torque.

5.7 Alarm Bell/ Intercom

A battery operated emergency alarm bell, including wiring to be provided and connected to a properly marked push button in the car-operating panel. The alarm bell shall be located at the ground floor, at the floor landing outside and adjacent to hoist way.

A two line EAPBX and intercom Telephones shall be provided in car, security room and one more location for emergency use.

5.8 Hoist way Gate Interlocks

Each host way gate shall be provided with interlock and which shall prevent the movement of the car away from the landing unless all are closed and locked. The interlock shall also prevent opening of gate except at the landing where the car is stopping or has stopped.

5.9 Counter Weight

The counter weight shall consist of cast iron weight containing structural steel frame and shall be equal to the weight of the complete elevator car and approximately 50% of the contract load. Counterweight is to be provided with over speed safety in case of passenger elevators.

5.10 Hitches Plates

Self-aligning (with isolation cushion) hitches plates of better roping shall be provided.

5.11 Speed Governor

The car safety shall be operated by a mechanical centrifugal speed governor located at the top of the hoist way. The governor shall actuate a switch when excessive descending speed occurs disconnecting power to the hoist motor and applying the break prior to deployment of the safeties.

5.12 Reverse Phase Relay

Reverse phase relays should be provided on the controller, which should be designed to protect the elevator equipment against phase reversal and single phasing and phase failure.

5.13 Digital Hall Position Indicator

A digital position indicator shall be provided on all landings indicating the position of the car in the hoist way at all times. Illuminating direction arrows shall indicate the direction of the travel.

5.14 Digital car position indicator

A digital car position shall be provided in each elevator car which shall indicate the landing at which the car has stopped or is passing. Illuminating direction arrows shall indicate the direction of travel.

5.15 Car door operator:

a) An electrical A.C/D.C. door operator shall be provided on the car to automatically operate and close the car door in the following manner.

b) When the car stopped at a landing the car door shall be opened by the electric operator. After the hoist way door has been closed, the pressing of either a car button or landing operating button at other landing shall cause the car door to close. An electric contact shall be provided to prevent the operation of the elevator unless the door is in the position.

5.16 Full Collective Automatic Operation

a) The operation shall be full collective automatic type with one button in the car for each landing level served and up and down buttons at the intermediate landings and a single button at each terminal landing. All stops registered by the momentary pressure of the car button shall be made in the order in which the landings are reached after the buttons have been pressed but irrespective of the sequence in which the calls were registered.

b) All up landing calls shall be answered when the car is traveling in the up direction and all down landing calls shall be answered when the car is traveling in the down direction, except in the case of the uppermost or lowermost calls which shall be answered as soon as it is reached.

5.17 Infra Red Door Safety

Car doors should have full infrared safety device. When any beam is interrupted, an electronic circuit shall be actuated and door operating mechanism shall return the doors to the open position and when the entrance is again clear, the elevator door closes automatically.

5.18 Fire Man Drive

Fireman drive shall be provided for each elevator. The operation of the fireman drive shall be in two phases.

In the first phase it shall cancel all the calls and bring the passengers to the parking floor. All the floor buttons shall remain ineffective till the button is reset.

In the second phase the fireman shall use it. In second phase operation the elevator door should open by continuous pressure on the door open buttons and the door shall close if the button is released before the door full open. And hall buttons giving car calls indication shall cause the door to close, and the elevator should run on slow speed. Doors should be fire rated for one hour and shall be provided with jam panels.

5.19 Automatic Rescue Device

Automatic (Emergency) battery device should come into operation in case of power failure it should sense the direction of motor and stop the elevator at the nearest floor landing and door should open. The automatic rescue device (drive) should be base on maintenance free batteries of suitable capacity –each elevator to have its own Automatic Rescue Device.

6 Test of Lift Installation

6.1 Tests at site:

a) Leveling Test:

Accuracy of the floor leveling shall be tested with the lift empty, fully loaded. The lift shall be run to each floor while traveling both in upward and downward directions and the actual distance of car floor above/ below landing floor shall be measured. In each case there shall not be any appreciable difference in these measurements for leveling at the floors when the car is empty and when it is fully loaded. The tolerances for leveling shall be specified and guaranteed by the tendered.

b) Safety Gear Tests:

With the contract load still in the car, the safety gear may now be tested, if the lift operates from a D.C. supply the excess speed necessary to operate the gear may be obtained by field weakening, but if A.C. motor is installed the gear may be set to operate at the contract speed or alternatively tripped by hand at the contract speed.

Instantaneous safety gear controlled by a governor should be tested with contract load and a contract speed, the governor being operated by hand. Two tests should be made, however, with wedge clamp or flexible clamp safeties, one with contract load in the car and other stopping distance obtained should be compared with the specified figures and the guides, car platform, and safety gear should be carefully examined afterwards for signs of permanent distortion. Note -: if there is sufficient cable left on the safety drum after the gear has operated.

Counterweight safety gear should be tripped by the counter weight governor and the stopping distance noted. In this case, however the governor tripping speed should exceed that of the car safety governor but by more than 10%.

During the safety gear tests an inspector with a tachometer should determine the car speed (from the governor or the main sheave) at the instant or tripping speed with that stated in I.S. The governor jaws and rope should be examined for any undue wear.

c) Contract Speed:

This should be measured with contract load in the car, with half load and with no load, and should not vary from the contract speed by more than 10%. The convenient method is by counting the number of revolutions, made by the sheave of drum in a known time, chalk mark on the sheave or drum and a stop switch will facilitate timing but care must be exercised to ensure that no acceleration or retardation periods are included, if the roping is 2 to 1 the sheave speed is twice the car speed. Alternatively, the speed can be measured by a tachometer applied directly to shaft immediately below the sheave.

d) Lift Balance:

After the above test, some of the weight shall be removed until the remaining weights represent the figures specified by the bidder. With this condition car at half way travel the effort required to move the lift car in either direction with the help of winding wheel shall be as nearly, be the same as can be judged.

e) Car and Landing Doors Interlocks:

The lift shall not move with any door open. The car door relay contact and the retiring release contact must be tested. The workings of the door operation and the safety edges and light equipment if any provided shall also be examined.

f) Controllers:

The operation of the contactors and interlocks shall be examined and it shall be ascertained whether all the requirements laid down in the specifications have been met.

g) Normal Terminal Stopping Switches:

These shall be tested by letting the car run to each terminal landing in turn, first with no load and then with contract load and by taking measurements, top and bottom over travels can be ascertained.

h) Final Terminal Stopping Switches:

The normal terminal stopping switches shall be disconnected for this test. It shall be ensured that these switches operate before the buffers are engaged.

i) Insulation Resistance:

This shall be measured between power and control lines and earth and shall not be less than 5 mega – ohms when measured with D.C voltage of 500 volts. The test shall be carried out with contactors so connected together as to ensure that all parts of every circuit are simultaneously tested.

j) Earthing:

All conduits, switches, casing and similar metal work shall have earthing continuity.

k) Ropes:

The size, number construction and fastenings of the ropes should be carefully examined and recorded.

l) Buffers:

The car should be run on to its butters at contract speed and with contract load in the car to test whether there is any permanent distortion of the car or buffers. The counter weight buffers should be tested similarly.

6.2 Tests at Manufacturer's Works:

a) High Voltage Test:

The dielectric or electrical apparatus (excluding motors, generators and instruments which are tested in accordance with the appropriate Indian Standards wherever they exist) shall be capable of withstanding a test voltage of ten times the working voltage with a maximum of 2000 volts when applied

i). between the live parts and case or frame with all circuits completed
ii). between main terminals or equivalent parts with all circuits open and
iii). between any live parts of independent circuits

Note: Owing to the impracticability of applying tests (ii) & (iii) mentioned above on controllers and similar apparatus after controller wiring has been completed, these tests may be made at convenient stages or manufacture.

b) Method of Applying High Voltage:

The test shall be made with alternating voltage of any convenient frequency, preferably between 49 and 60 cycles per second. The test voltage shall be of approximately sine-wave form and during the application of voltage with peak value, as would be determine by spark gap by orcillograph or by any other approved method shall of the applied voltage shall be measured by means of a transformer or by means of a voltmeter used in connection with a special calibrated voltmeter winding or testing transformer by any other suitable voltmeter connected to the output side of the testing transformer.

Duration of High Voltage Test:
The test shall be commenced at a voltage of about one third of the test voltage which shall be increased to the full test voltage as rapidly as is consistent with the value being indicated by the measuring instrument. The full test voltage shall be maintained for one minute. At the end of this period, the test voltage shall be rapidly diminished to one third of its full value before switching off.
The oil buffers are examined after the above tests have been made to determine if there have been any oil leakages or distortion and to ensure that the buffers return to their normal position.

c) Service Temperature Test:

A continuous run of one hour should be made with number of starts and stops to reproduced as nearly as practical the anticipate duty in service (The standard duty cycle is for 90 to 180 start per hour). It is very difficult in practice to carry out this test with alternate starts at full load and no load and it is very necessary therefore to simulate these cycles. A suitable test for all motor except squirrel cage motors is to run the cat up from the bottom landing with contract load and stop at each floor. From the top floor a non stop run is made to the lowest floor and the upward journey with stop is then repeated. The time intervals between stops and starts at the floors should be uniform and such as to give about 120 starts in one hour. At the end of this run the temperatures of the armatures and fields of the motors and generator are record. The temperature rise should, not exceed 55oC or 75oC for classes. A or E insulation respectively.

d) Buffer test:

Copy of the test report shall be intimated after testing at works.

7 Detailed Requirement of Passenger Elevator

Lift Type	Passenger Lift (13P, 884kg) (Machine Room Less)
No. of lifts	2
Speed	1.5 m / s
Travel & Rise	7.8 mtrs. Approx.
Floors served	Ground Floor, 1st Floor & 2nd Floor
Stops & Openings	3 Stops & 3 Openings (All opening on same side)
Power supply	415 V, 3 phase, 50 Hz AC
Control	AC Variable voltage variable frequency

Operation	DUPLEX with/ without attendant
Machine	Gearless placed in Lift Shaft
Car Size	2000 mm wide x 1100 mm deep inside dimension
Hoist way available	As per drawing (approx. 2500 mm x 1900 mm)
Car enclosure	SS Sheet steel Scratchproof/ Moon Rock finish with Glass Panel on Rear side
Car entrance	Central opening sliding stainless steel Scratchproof / Moon Rock finish doors Clear opening 900 mm wide & 2100 mm high
Hoist way Entrances	Central opening sliding stainless steel Scratchproof finish doors Clear opening 900 mm wide x 2100 mm high.
Door operator	Automatic with AC-Door operator having VF – Controls
Hand rails	Stainless steel
False ceiling	Acrylic / Perspex Ceiling
Flooring	PVC Flooring / Vinyl tiles 3.0 mm thick
Signals	Combined luminous hall buttons and digital hall position indicator with directional arrow. Integral full height car operating panel with luminous buttons Digital car position indicator combined with directional arrow. Battery operated alarm bell and emergency light with batteries as required. Overload warning and service cabinet. Auto fan ON/OFF feature. LED Lights in the car. Fireman's switch at ground floor Intercom system in car (in built) (for 3 position in built feature) All plates should be of stainless steel
Door Safety	Mechanical & Full height infrared door protection system Face plate in hair line finish of stainless steel and of rectangular shape
ARD	Automatic Rescue Device

7.1 Instructions to be displayed in Hindi/ English inside the lift car

S.No	Description
1	Lift Number
2	Capacity
3	Persons
4	No smoking
5	Operate push buttons/ switches correctly
6	Do not lean against the lift door
7	Do not panic in the event of breakdown press alarm buttons and follow instructions of authorized staff.
8	Use Telephone/ intercom kept inside the car for help

ELECTRICAL WORKS

1 GENERAL

1.1 SCOPE OF WORKS

The scope of work under the sub head 'Internal Electrical Works' includes the following:

a) Wiring for light & Fan points.
b) Wiring for 6A LP socket outlets.
c) Wiring for 16A & 20A Power socket outlets.
d) L.T. Cables and Sub main wiring.
e) Rising Mains and Bus Duct.
f) M.V. panels and Distribution Boards.
g) Supply and Installation of Light fittings, fans & fixtures.
h) Earthing/Lightening Arrestor.
i) Wiring for Telephone points
j) Wiring for Networking /LAN points.
k) Automatic Fire Detection and alarm system

The Bidder shall include for the supply (unless specified otherwise), delivery, installation, connection, commissioning and testing of all materials and equipment to provide a complete electrical system.

1.2 STANDARDS AND CODES OF PRACTICE

The electrical Installation work shall be carried out in accordance with Indian Standard Code of Practice. It shall also be in conformity with the current Indian Electricity rules and regulations and requirements of the Local Electricity Supply Authority and Fire Insurance regulations so far as these become applicable to the installation. Electrical work in general shall be carried out as per following CPWD Specifications.

a) General Specifications for Electrical Works (Part-I) Internal Work – 2013
b) General Specifications for Electrical Works (Part-II) External Work – 1995
c) General Specifications for Electrical Works (Part-III-LITS & Escalators) – 2003
d) General Specifications for Electrical Works Part IV Sub Station – 2013
e) General Specifications for Electrical Works Part VII D.G. Sets – 2013
f) General Specifications for Electrical Works Part VIII Gas Based Fire Extinguishing System – 2013
g) General Specifications for Heating, Ventilation & Air-Conditioning (HVAC) – 2004

The work shall be carried out as per the enclosed Specifications of Work and the construction drawings to be issued from time to time. These specifications shall be read in conjunction with relevant Codes of Practice and Standards as issued by BIS (all with the latest amendments) and with 16th edition of wiring regulation of I.E.E.

Wherever these specifications calls for a higher standard of material and or workmanship than those required by any of the above mentions regulations and specification then the specification here under shall take.

1.3 I.E. RULES COMPLIANCE

The installations and equipment supplied shall comply in all respects with the Indian Electricity Act and the Indian Electricity Rules (1956) amended as on date.

1.4 ELECTRICAL DRAWINGS

The electrical drawings issued from time to time to the Contractor are diagrammatic but shall be followed as closely as actual construction and work will permit. Any deviation from the drawings required to conform to the building construction shall be made by the Contractor at his own expenses. The architectural drawings shall take precedence over the services drawings as far as the Civil and other trade works are concerned.

DISCREPANCY IN DRAWINGS

Should there be any discrepancy due to in -complete description, ambiguity or omission in the drawings and other documents relating to this Contract found by the Contractor either before starting the work or during execution or after completion, the same shall be immediately brought to the attention of the Engineer-in-Charge and his decision would be final and binding on the Contractor.

1.5 INSTRUMENTS FOR MEASUREMENT AND TESTING

The Contractor shall provide, free of cost, all equipments, instruments, labour and all other allied assistance required by the Engineer-in-Charge for measurement and testing of the works.

1.6 CO-ORDINATION WITH OTHER TRADES

The Contractor shall be responsible for coordinating this work with works of other trades sufficiently ahead of time to avoid unnecessary hold ups. Hangers, sleeves, recesses etc. shall be left in time as the work proceeds.

1.7 PROTECTION

All work shall be adequately protected, to the satisfaction of the Engineer-in-Charge, so that the whole work is free from the damage throughout the period of construction upto the time of handing over.

Special care must be taken to prevent damage and scratching of all fittings and fixtures. Tool marks on exposed fixtures shall not be accepted. Protective paper on fixtures shall be removed with hot water only at the final completion of the work.

Before handing over the work, the Contractor shall clean all elements of the complete installation, remove plasters, splashes, stickers, rust stains and all other foreign matter and leave every part in acceptable condition and ready for use to the satisfaction of the Engineer-in-Charge.

1.8 SAFETY PRECAUTIONS

The Contractor shall take all reasonable safety precautions during construction and testing of the works. Particular attention shall be paid to the following:

a) Precautions to the Engineer's approval shall be taken to prevent any conductor or apparatus becoming accidentally or inadvertently charged when persons are working thereon.

b) Prior to the electrical installation (or part thereof being contractor shall ensure that all main switches on equipment in his supply are padlocked off, so that un-commissioned or incomplete circuits cannot be used without the Engineer's consent.

During testing and commissioning or at any other time, when live conductors may be temporarily exposed (e.g. control panel doors open) the Contractor shall provide danger boards and warning signs to the approval of the Engineer to prevent any possibility of accidental electric shock.

1.9 'AS-FITTED' DRAWINGS

The Contractor shall submit, after the completion of the work, one set of originals and two sets of prints of the 'As-Fitted' drawings, giving the following information.

a) Position of all light, fan and other outlets, MDBs & SDBs.
b) Conduit layout.
c) Single line diagram for internal works.
d) External lighting schemes, cable route etc.

1.10 OPERATION & MAINTENANCE MANUALS

The Contractor shall hand over to the Owner all operation and maintenance manuals of the plant and equipment supplied and installed by him. Only manufactures catalogues wiring diagrams and installation drawings, relevant to particular items of equipment concerned shall be submitted. General catalogues will not be accepted.

2 L. T. PANELS

2.1 All ACB shall be with Ics as 100 % Icu and Icw = 1Sec

2.2 All MCCB shall be provided with door interlocked rotary handle with ON/TRIP/OFF position indicator MCCB can be mounted vertically/horizontally.

2.3 All ACB's shall be with microprocessor based release. Protection functions for different type of releases as specification.

2.4 Spare contacts of ACB/Relays/Contactor etc. shall be wired up to terminal block.

2.5 All outgoing terminals (power and control) shall be brought up to cable alley. 10% extra terminals shall be provided for control ckt.

2.6 All CT, PT shall be cast resin type. All CTs should be clamped & name plate should be visible.

2.7 All meters shall be digital type & door mounted type.

2.8 All incomer meters of Main LT Panel, DG Panel shall be multi-function meter EM6400 or Equivalent & should have all the electrical parameters like Current, Voltage, kW, kVAR, kWH, PF, Frequency etc with RS 485 port.

2.9 Panel shall be powder coated of approved colour shade with minimum 80 micron thickness.

2.10 Bus bar chamber shall be kept at top of all panels.
2.11 All bus bar shall be insulated with PVC Sleeve.
2.12 Internal wiring of panel shall be with size 2.5sqmm Flexible Copper Conductor for CT circuit and control wiring with 1.5 sq. mm.
2.13 All indicating light shall be LED type.
2.14 Each vertical section of floor mounted panel shall have independent base frame (75mm x 40mm) size made out of from 5mm sheet steel for main LT Panel & DG Panel.
2.15 All ACB shall be provided with ON/OFF/TRIP indicating lamps.
2.16 All the accessories shall be as per approved make list only.
2.17 Separate UPS Power Supply along with maintenance free battery suitable for operation of PLC for interlocking in main LT Panel/ DG Panel shall be supplied by the vendor. The back-up duration of battery shall be suitable for 30 minutes.
2.18 Separate DC Power supply power pack along with battery for the operation of trip ckt in main LT Panel & DG Panel shall be supplied by the vendor. The back - up duration of battery stand by shall be suitable for 30 minutes.
2.19 Control scheme to be submitted by vendor for approval.
2.20 Suitable Aluminium earth bus to be provided throughout the length of Switch boards.
2.21 Vendor should supply the CPRI test report:
3 For Short Circuit strength at 65 kA RMS for 1 Second.
4 For temperature rise test.
2.22 All shrouds shall be poly carbonated & all hardware shall be high tensile.
2.23 Doors & louvers shall be covered with gaskets to obtain totally enclosed, dust & vermin proof enclosure having IP: 52 Protection rating.
2.24 Space heater shall be provided with thermostat with 6A MCB as back up protection in each feeder section of Main LT Panel/DG Panel.
2.25 All panels shall have provision to accommodate all cables from the bottom and top (Both).
2.26 GI hardware with zinc passivation shall be used in Assembly of Switch boards.
2.27 Vendor shall provide 9" diameter Exhaust fan in all incomers, bus-coupler & capacitor bank of DG & Main LT Panel.
2.28 An approval of GA/SLD/BOQ/Schematic drawings shall be taken for each panel before manufacturing.

3 AIR CIRCUIT BREAKERS

3.1 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, ASTA /any accredited international lab. The circuit breaker shall be suitable for 415 V + 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.
3.2 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. Short circuit withstand values (Icw) for 3 sec has to be minimum 50KA.
3.3 Main LT Panel : Icu=Ics=Icw = 65KA for 1Sec.
3.4 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 open when circuit breaker is closed and breaker should not be closed when door is open.
3.5 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.

3.6 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 3 NO and 3 NC auxiliary contacts shall be provided on each breaker. Rated insulation voltage shall be 1000 volts AC. Desired Watt Loss/Per Pole Data should be as per attached sheet.

ACB Rating (Draw-out type)	Max. Power Consumption (watts)/Per Pole
800/1000A	40
1250A	60
1600A	77
2000A	100
2500A	113
3200A	143
4000A	240

3.7 Cradle

3.7.1 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.

3.7.2 There shall be 4 distinct and separate position of the circuit breaker on the cradle. Racking Interlock in Connected/ Test/ Disconnected Position.

3.7.3 Service Position: Main Isolating contacts and control contacts of the breaker are engaged.

3.7.4 Test Position: Main Isolating contacts are isolated but control contacts are still engaged.

3.7.5 Isolated Position: Both main isolating and control contacts are isolated.

3.7.6 There shall be provision for locking the breaker in any or all of the first three positions.

3.7.7 The following safety features shall be incorporated:

3.7.8 Withdrawal or engagement of Circuit breaker shall not be possible unless it is in open condition .Operation of Circuit breaker shall not be possible unless it is fully in service, test or drawn out position. 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. All Switchgear module front covers shall have provision for locking. Switchgear operating handles shall be provided with arrangement for locking in 'OFF' position.

3.8 Protections

3.8.1 The breaker should be equipped with micro-controller based release 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 with intentional time delay
- Short time protection with intentional delay
- Instantaneous protection option for "Off"
- Ground fault protection with time delay

The protection release shall have following features and settings:

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.

Thermal Memory

When the breaker shall re close 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.

Trip Indication

Individual fault indication for each type of fault should be provided by LEDs for faster fault diagnosis.

The release shall meet the EMI / EMC requirements.

The setting range of release shall be generally as follows:

- SETTING RANGE OF RELEASE
- Type of Protection
- PICK-UP CURRENT TIME DELAY
- Long Time 0.5 to 1.0 times In
- Steps of 0.05
- Operating Limit : 1.05 to 1.20 times Ir
- 12 to 150 sec at 2 Iu
- Short Time 1.5 to 10 times Ir
- Tolerance : ±15%
- 50 ms to 600 ms
- Tolerance : ±20%
- Instantaneous 2 to 15 times In With OFF option
- Pre Alarm Current 0.7-1.0Iu
- (Optional for critical feeders)

The release should provide display of actual % age loading at any instant in absolute value and in bar graph. Release if with Display should be able to capture short circuit current on which ACB has tripped. The last ten trips shall be stored in memory with the date & time stamping along with type of fault.

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.
- Earth-fault protection with an adjustable pick-up and time delay shall be provided if indicated on the appended single-line diagram.

3.8.2 Safety Features

The safety shutter shall prevent inadvertent contact with isolating contacts when breaker is withdrawn from the Cradle. It shall not be possible to interchange two circuit breakers of two different thermal ratings. 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. 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. 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.

4 MOULDED CASE CIRCUIT BREAKERS

4.1 GENERAL

Moulded case circuit breakers shall be incorporated in the Main Distribution Board and Sub Distribution Board wherever specified. MCCB's breaking shall be suitable either for single phase AC 230 volts or three phase 415 volts AC at 50 Hz. MCCB shall have class-II front face with no live parts accessible to the user.

The MCCB shall be suitable for isolation as per IS/IEC with clear ON/OFF indicator. The Circuit breaker shall comply with IEC60 947-2 and IS 13947 part 2. The MCCB shall be suitable for isolation as defined by IEC60947-2.

The breaking capacity performance certificate shall be available for category A to the above mentioned standards along with disconnection function requirements. The test shall be carried out under the breaking performance during operation (Ics) equal to 100 % of the ultimate breaking capacity (Icu), with following minimum services Breaking capacity

it breakers shall have a rated operational voltage of 690V AC. The rated insulation voltage shall be 690V.

Thermal requirements: MCCB shall have minimum breaking capacity of 36KA.

All circuit overload release adjustment can be done from a single point. MCCB cover needs not to be opened for doing such adjustment.

Electrical endurance of MCCBs at full load shall be of as follows.

- 125A – Min. 35000 operations
- For above than 125 A and upto 250A – Min. 12000 operations.
- For above than 250 A and upto 630 A – Min. 4000 Amp.

All MCCB's shall have spreaders and phase barriers on each terminal. The Breaker shall be maintenance free and fully tropicalized.

4.2 CONSTRUCTIONS

The MCCB cover and case shall be made of high strength heat treatment and flame retardant thermo setting insulating material. Operating handle shall be quick make/ quick break, trip-free type. The operating handle shall have suitable "ON" "OFF" and "TRIPPED" indicators. Three phase MCCBS shall have common operating handle for simultaneous operation and tripping of all the three phases. MCCB's shall have frame sizes as under;

- 100-250A – First Frame
- 400-630A – Second Frame

All Accessories shall be snap fitted type and common for entire range i.e upto 630A. Tripping unit shall be of thermal magnetic or Microprocessor type provided in each pole and connected by a common trip bar such that tripping of any one pole operates all three poles to open simultaneously. Thermal magnetic or microprocessor tripping device shall have IDMT characteristics for sustained over loads and short circuits. MCCB shall confirm to RoHS regulated substances and compatible values to recycle at the end of product life. Contacts trips shall be made of suitable are resistant, sintered alloy for long electrical life. Terminals shall be of liberal design with adequate clearance.

4.3 Protections requirements

MCCBs shall comprise a device, designed to trip the circuit-breaker in the event of high-value short-circuit currents. This device shall be independent of the thermal-magnetic or electronic trip unit. The breaking will be carried out in less than 10ms for short-circuit currents above 20In. MCCBs with ratings up to 250A shall be Thermal Magnetic type. 400A and onwards shall be with Microprocessor trip units.

5 FIRE DETECTION & ALARM SYSTEM

5.1 General

Fire detection and alarm system consists of microprocessor based Intelligent addressable fire alarm panel, intelligent addressable detectors, intelligent addressable manual call points, intelligent addressable input and output modules, Intelligent Addressable electronic hooters, response and floor indicator, repeater panels. All the components and panels shall be of one make. The System offered should be complete in all respect

including supply of equipment's, conduiting, wiring etc. and shall meet the requirement of applicable standards.

In the event of a fire alarm, but not in a fault condition, the following action shall be performed automatically.

The system Alarm LED on the main fire alarm control panel shall flash.

a) Hooters in the control panel and in plant shall be sounded.
b) Air Handling Units on affected floors shall automatically be switched off And

Simultaneously respective fire dampers shall also be closed.
The panel shall have all necessary provisions for interfacing with BMS, smoke evacuation system, Air handling units, fire fighting equipment, elevators, access control system, and other third party systems.

5.2 Fire Alarm Panel

a) Maximum system availability will be realized by decentralizing the system intelligence whereby the detection and evaluation task is performed by the detector. The FAP will verify and process the detectors output signals in conjunction with the pre-defined used data, e.g. display the event, perform pre-defined control, signal tasks and respond to manual commands entered by the system operator.

b) The FAP will fully comply with the requirements of the standard EN 54/ UL/FM/VdS/BS/LPCB.

c) A modular assembly concept will allow the FAP to be split into number of units. In order to economize on the field wiring installation for the detection and control devices, these sub units will be installed at the most suitable location with a data link connection to a common operation terminal. All operational and technical requirements are as detailed herein for CPU/ Master control unit's included in the FAP.

d) The FAP will be capable of operating conventional/collective, analog and interactive detector lines. A combination of these circuits in the same FAP, for the initial installation or for any future system expansions, will be possible.

e) The FAP will be capable of communication with remote operating terminals. Each terminal will be pre-programmable to operate on the whole of the detection system or only a certain section of it.

f) In addition to the fire detection devices, it will be possible for the FAP to evaluate and operate signals from the following devices by using appropriate modules:
   - Sprinkler flow switches.
   - Stand-alone gas detection systems
   - Stand-alone automatic extinguishing systems.
   - Information form technical plant equipment.

g) It will be possible to freely locate and group detectors according to the geographical and architectural requirements of the user premises. This will allow maximum user orientation in the case of an alarm event.

h) To optimize the response characteristics of automatic detectors, it will be possible to monitor these and to download different algorithms sets.

i) An audible and visual application-warning signal will be activated per detector, if the response characteristic of the detector does not correspond with the environmental conditions it is operating in.

j) The panel shall provide a minimum ¼" VGA Graphic display or minimum160 character alpha numeric LC Display.

5.3 Detector Line Communication

a) The FAP will be able to process in-coming signals from Intelligent Analog addressable devices, such as detectors, manual call points, input and output modules etc. via two wire line.
b) The loop capacity will allow the handling of upto 200 Analog addressable devices.
c) A drift indication will permit, automatically or upon request, status information of an automatic smoke detector.
d) An address will be freely assigned to all the devices that have been connected to an Analog detector line.
e) The Analog addressable detector line will at least process the following verified signal condition between the detection devices and FAP.
f) Adjusting the detectors sensitivity level.
g) Changing the detectors response characteristics.
h) Multi-zone evaluation.
i) The system will be able to identify the type of detector installed in each base and consequently, verify this information during normal operation and service.

5.4 Hardware Configuration/ Mechanical Design

a) The FAP will consist entirely of standard modular printed circuit board assemblies to facilitate removal, easy maintenance and modular system expansion.
b) Provide a 32 bit central CPU module for controlling an operating terminal and an internal bus onto which detection lines, various input/output modules, bell and remote alarm circuits can be connected.
c) Provide an ac/de converter module with charging unit.
d) Provide line/Loop modules to operate Analog addressable detectors/devices.
e) Provide a battery capacity of minimum 48 hours emergency supply in standby mode and 30 minutes in an alarm condition.
f) Processing capacity:
g) The FAP will be able to handle the following capacities.
h) 800 data points (detection devices)
i) 4 Analog addressable type detecting circuits or
j) 800 programmable control outputs.
k) 800 programmable monitored inputs.
l) Capacity to operate 16 Repeater Panels.
m) The panel should with inbuilt interface for connecting Repeater panels and PC and no extra module should be required for that.
n) The panel should be network ready and no extra module should be required to network more than one Panel.
o) It should be possible to UPLOAD and DOWNLOAD the program to and from the panel.

5.5 Application Warning

The FAP will be capable of monitoring the frequent occurrence of warning signals released by an automatic detector. This will occur if the detection response behavior of the detector does not correspond to the environmental conditions the detector is operation in. An application warning will then be displayed by means of an audible and visual indication at the operating terminal.

Multi-Detector Logic

It will be possible to indicate an alarm signal at the operation terminal if two or more automatic detector, monitoring the same area, activates a warning signal.

Access Levels and Password

Operator access shall be granted via different access levels protected by the passwords.

History File

The FAP will save and display the date of at least 1000 system-operating events.
The historical data will be displayed at the operating terminal as follows:

- All messages listed in a chronological order.
- All test alarms.
- All test alarms from the same date.
- All faults listed in chronological order.
- All isolate off connect and normal conditions in chronological order.
- All information.
- All active control functions.

Repeater panel

The FAP will be designed such, that the Repeater panel serving as a Interface to be installed at a remote location.

Remote repeater panels for repeating all alarm status indication with LCD display shall be provided at the specified location and shall be VdS/EN/UL/NFPA/BS/LPCB approved. The repeater panel shall have identical zoning and colour display for all alarms and shall fully correspond to those in the Main control panel.

The repeater panel shall be provided with warning buzzer, which shall activate when an alarm occurs in the fire control room and a push switch shall be provided for silencing the warning signal. Lamp test control switch shall also be provided in the panel.

The panel shall contain an integral backlit LCD display of minimum 160 characters. LCD display shall be viewable through the panel door.

The repeater panel enclosure shall be flush mounted and all electronics shall be contained in the enclosure. Access to the repeater panel switches shall be protected by key-switch/ passwords.

5.5 Systems Devices

Multi-Criteria Detectors (Combined Heat & Smoke)

The design of the smoke sensitive system shall guarantee a uniform response behavior to all combustion products of smoke-forming flaming and smoldering fires. The detection principle shall employ a multiple light pulse coincidence circuit for smoke sensor and thermistors for Heat sensing element. The smoke detector shall conform to EN 54-7/9/UL/VdS/NFPA/BS5839.
The detector shall be controlled by a custom designed application specific integrated circuit (custom – ASIC) in order to guarantee a maximum reliability of the electronic circuit.
The detector shall be able to transmit up to two (2) alarm-level information to the control unit for evaluation according to the customer specific programming of the control unit.
The electronic circuits of the detector shall be internally supervised and be able to signal up to two (2) different status information to the control unit.

The detector shall be able signal deviations from the standard sensitivity to the control unit.
The detector shall be equipped with a response indicator and shall have the possibility to drive remote indicators in order to signal alarm conditions. The LED on the detector shall blink under normal condition to indicate healthy communication.

The detector shall be able to isolate short circuits on the detector-line bus in order not to disrupt the proper function of the rest of the detectors connected on the detection-line bus. Each detector shall have in-built isolator or a separate isolator base/ module. Reversed polarity of faulty wiring shall not damage the detector.

The detector shall be individually identifiable from the control unit by geographical location in the system. The detector shall support soft addressing only and no manual mode of setting the address of the detector shall be allowed. All electronic circuits shall be in the detector head, thus not requiring any active electronic circuits in the base.

The detector shall connect to the local control unit via a fully supervised two-wire circuit (Class A and Class B wiring). A twin twisted shielded type of cable shall be employed. The detector shall have a digital communication with the control unit on the basis of error recognizing protocol with multiple transmission of information.

The system shall be able to signal a priority alarm message no less than two (2) seconds after the detector has recognized this situation.

The optical chamber shall be disposable type. Cleaning or replacing the detector's chamber will allow the detector to reset its digital parameters as well. A built in barrier shall prevent the entry of insects into the sensor. The detector shall be designed for easy dismantling for cleaning at site and no factory cleaning shall be required.

The detector shall be inserted into a base without the need of tools. The base of the detector shall be interchangeable with other Multi-Criteria detectors. The base shall include all necessary terminals to connect installation wiring.

The base shall allow the removal of the detector without disconnecting the installation wiring. The detector shall be inserted into or remove from the base by a simple push-twist mechanism with an appropriate tools up to 7m above floor level. The heat element shall employ the thermistor principle for heat.

The Multi-criteria detector shall support at least 3 smoke modes and 3 heat modes. It should be possible to select any combination of above three modes.

Manual Call Point, Analog Addressable

The alarm shall be activated by breaking the glass without the need of an additional instrument (e.g. hammer).

The glass plate shall be designed in away to prevent injuries when struck by the operator. The manual call point shall be controlled by a custom designed application specific integrated circuit (custom – ASIC) in order to guarantee a maximum reliability of the electronic circuit.

The call point shall have a digital communication with the control unit on the basis of error recognizing protocol with multiple transmission of information.

The call point shall have a built in LED, which will be illuminated upon actuation of the manual call point.

It shall be possible to test the manual call point without destroying the covering window.

Unauthorized removal of the call point's cover must release an alarm.

The manual call point shall comply with standard EN 54-11 or BS 5839-2.

The call point shall fit on a surface -mounting box, which contains at least three terminals for the connection of the filed wiring.

It shall be possible to mount the part containing the sensitive electronic circuit separately just before commissioning, thus preventing any possible damage due to inappropriate installation work.

Monitor Input Module, Analog Addressable

The analogue addressable input module shall be designed to be capable of being connected along with other analogue addressable elements on a loop. The devices shall be interfacing a stub line for simple dry contacts (switch) to the analogue addressable loop.

The monitored input may be supplied either as built-in each multi-criteria detector or as a separate monitored module.

The stub line shall be supervised with an end-of-line resistor.

Programmable normally open or normally closed contracts shall be usable.

The analogue addressable input module shall receive all its power requirements through the analogue addressable detection loop.

Control Output Module, Analog Addressable

The analogue addressable output module shall be designed to be placed somewhere along the other analogue addressable devices on a detector loop. The device shall provide an interface as a control of the fire alarm panel to equipment such as fire doors, smoke vents, smoke curtains, AHUs, Pressurization fans, etc.

The module may be supplied either as built-in in the multi-criteria detector or as a separate module on the detection circuit.

The output control device should be controllable by any detector connected to the same fire detection control unit.

No additional power supply shall be required to activate the relay output.

The analogue addressable output module shall be equipped with to activate the device for testing and for assigning its address during commissioning.

Addressable Loop Sounder cum Strobe

The addressable loop sounder cum strobe should be able to draw its power from the same detection loop and no external power supply unit/ wiring shall be required to operate the sounder cum strobe.

No extra control module or any other module shall be used in order to make the sounder addressable.

The sounder shall be suitable for a maximum output of 84 dB(A) at 1 meter. The sounder should be with minimum 7 different tone setting and 3 volumes settings selectable from the Main Fire Alarm Panel or PC. The sounder may be an integral part of multi-criteria detector and Manual Call Points.

6 STREET LIGHTING

6.1 SCOPE

The specifications cover the supply, installation, testing and commissioning of the following items:

I. Street lighting poles complete with all accessories e.g. looping box, clamps MCBs and required hardwares etc.
II. Street lighting fixtures complete with all accessories e.g lamps, holders, choke, upto terminal box etc.
III. Wiring of street light fixtures.
IV. Cable laying, earthing and inter connection. G.I. pipes for cable entry to looping box.
V. Foundation of poles and erection.
VI. All the items should be tested and installed as per the latest Indian standards specifications and all the sundry items such as clamps, bolts, nuts, racks, support miscellaneous wiring etc., required to make the installation complete shall be taken care while quoting the major items.

6.2 GALVANISED CONICAL POLES

Design: The Conical Poles shall be designed to withstand the maximum wind speed of 160 km / hr. 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 / BSEN 40.

Pole Shaft: The pole shaft shall have circular 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 conical pole shafts shall be provided with the rigid flange plate of suitable thickness with provision for fixing 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.

Door opening: The conical 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.

Material: Conical Poles shaft HT steel Conforming to grade S355JO, Base Plate Fe 410 conforming to IS 226 / IS 2062, Foundation Bolts EN 8 Gr. As per IS 1367

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 conical shafts.

Pole sections: The conical poles shall be in single section (upto 11 mtr). There shall not be any circumferential weld joint.

Galvanization: The poles shall be hot dip galvanized as per IS 2629 / IS 2633 / IS 4759 standards with minimum coating thickness of 65 micron. The galvanizing shall be done in single dipping.

Manufacturing: The manufacturing unit shall be ISO 9001: 2000 & ISO 14001

Pole Testing Facility: The manufacturing unit shall have in-house pole testing facility for validation of structural design data. The pole testing facility shall conform to BS EN 40-3-2-2000 part 3-2.

Fixing Type: The conical poles shall be bolted on a pre-cast foundation with a set of foundation bolts for greater rigidity.

6.3 ERECTION OF POLE

While loading, transporting, unloading and erecting the poles care shall be taken so that the poles do not get bent. Out of shape and where necessary such defects shall be rectified before the poles are erected in position. The poles shall be erected in plumb line and correct level as indicated in the drawing and to the satisfaction of the Engineer-in-charge. They shall be kept in this position with the help of manila ropes until the foundation are constructed (for a minimum period of 10 days) and the back filling is complete. Foundation shall be made with reinforced cement concrete (1:2:4) and not less than 200 mm thick all round. The pole base plate shall be fixed over 150 mm thick concrete bed. Foundation shall be continued upto 300 mm or more above ground level as per location of the pole to avoid ingress of water logging etc. The foundation shall be tapered suitably into a collar. The excavated portion shall be filled back with earth and consolidated. The cement concrete foundations shall be cured properly by covering the same with water soaked or moist gunny bags at least two weeks before loading the pole.

6.4 ERECTION OF LIGHT FIXTURES

Each light fixture shall be connected to the supply through MCB of a suitable rating mounted in the looping box. The fitting shall be fixed to the pole properly and securely.

6.5 WIRING OF LIGHT FIXTURES

The wiring of lighting fixtures from terminal block by means of 2.5 Sq.mm PVC insulated two core copper conductor through a suitable rated MCB and neutral. Cost of two core connecting cable from junction box to lighting fixture and earth wire complete with connections are included in the quoted rate.

6.6 CABLING WORKS

All cable installation work shall be done as per relevant clauses of section cable work.

6.7 TESTS

The following tests shall be carried out before handing over the installation, tests on all fittings and cables as per IS specification:

1 Meggar test
2 Continuity test
3 Polarity test and phase sequence test

LIST OF BUREAU OF INDIAN STANDARDS (B.I.S.) CODES

The materials and workmanship shall be in accordance with the requirement of the appropriate BIS code wherever applicable together with any building regulations or bye-laws governing the works.

The following list is indicative and not exhaustive and the omission of any BIS code from the list does not relieve the contractor from compliance and doing the job as per the acceptable standards and the professional norms.

IS 1200	:	Mode of measurement.
IS 8112 IS 3812, 1981	:	Ordinary portland cement 43 Grade. Flyash for use as pozzolana and admixtures,
IS 2386	:	Method of test for aggregate for concrete.
IS 516	:	Method of test for strength of concrete
		Coarse and fine aggregate from natural sources for concrete.
IS 1077, 1986	:	Method of test for strength of Bricks.
IS 456 2000	:	Code of practice for plain and reinforced concrete.
IS 1597	:	Code of practice for construction of stone masonry.
IS 1597 PART 1	:	Code of practice for construction of rubble stone masonry.
IS 6313 PART 2	:	Anti-termite measures in buildings, pre-constructional chemical treatment measures.
IS : 210	:	Grey Iron Castings
IS : 226	:	Structural Steel (Standard Quality)
IS : 800	:	Code of Practice for Use of Structural Steel in General Building Construction
IS : 806	:	Code of Practice for Use of Steel Tubes in General Building Construction
IS : 813	:	Scheme of Symbols for Welding
IS : 814	:	Covered Electrodes for Metal Arc Welding of (part I & II) Structural Steel
IS : 816	:	Code of Practice for Use of Metal Arc Welding for General Construction in Mild Steel
IS : 822	:	Code of Practice for Inspection of Welds
IS : 961	:	Structural Steel (High Tensile)
IS : 1024	:	Code of Practice for Use of Welding in Bridges and Structures Subject To Dynamic Loading
IS : 1030	:	Carbon Steel Casting for General Engineering Purposes
IS : 1120	:	Coach Screws
IS : 1161	:	Steel Tubes for Structural Purposes
IS : 1182	:	Recommended Practice for Radiographic Examination of Fusion Welded Butt joints in Steel Plates
IS : 1363	:	Black Hexagon Bolts, Nuts and Lock Nuts and Black Hexagon Screws
IS : 1365	:	Slotted Countersunk Screws
IS : 1367	:	Technical Supply Conditions for Threaded Fasteners
IS : 1915	:	Code of Practice for Steel Bridges
IS : 2016	:	Plain Washers

IS : 2062	:	Structural Steel (Fusion Welding quality)
IS : 3757	:	Specification for High Tensile Friction Grip Bolts
IS : 5624	:	Specification for Foundation Bolts
IS : 3063	:	Single Coil Rectangular Section Sprint Washers for Bolts, Nuts and Screws
IS : 3443	:	Crane Rail Sections
IS : 3600	:	Code of Practice for Testing of Fusion Welded (part I) joints and Weld Metal in Steel
IS : 4923	:	Hollow Steel Sections for Structural Use
IS : 6227	:	Code of Practice for Use of Metal Arc Welding in Tabular Structure
IS : 801	:	Code of Practice for Use of Cold Formed Light Gauge Steel Structural Members in General Building Construction
IS : 811	:	Specifications for Cold Formed Light Gauge Structural Steel Sections.
IS : 823	:	Procedure Coat for Metal Arc Welding of Mild Steel
IS : 1024	:	Code of Practice for Welding of Structure Subject To Dynamic Loading
IS : 1261	:	Code of Practice for Seam Welding in Mild Steel
IS : 1323	:	Code of Practice for Oxy Acetylene Welding for Structure Work in Mild Steel.
IS : 383	:	Code of Practice for specification for coarse sand.
IS : 2645	:	Code of Practice for specification for integral cement water proofing compound.
IS : 7193	:	Code of Practice for specification for glass fibre base bitumen felt.
IS : 8112	:	Code of Practice for specification for 43 grade ordinary Portland cement.
IS : 12118	:	Code of Practice for specification for two part polysulphide based cement.
IS : 13826	:	Code of Practice for method of test for water proofing.
IS: 4926	:	Code of Practice for Ready Mix Concrete.

LIST OF BUREAU OF INDIAN STANDARDS CODES

All equipment, supply, erection, testing and commissioning shall comply with the requirements of Indian Standards and code of practices given below as amended upto 30th April, 2003. All equipment and material being supplied by the contractor shall meet the requirements of IS, electrical inspectorate and Indian Electricity rules and other Codes / Publications as given below:

1. General

SP : 6 (1)	Structural Steel Sections
IS : 27	Pig Lead
IS : 554	Dimensions for pipe threads where pressure tight joints are required on the threads.
IS : 779	Specification for water meters (domestic type).
IS : 782	Specification for caulking load.
IS : 800	Code of practice for general construction in steel
IS : 1172	Code of Basic requirements for water supply drainage and sanitation.
IS : 1726	Specification for cast iron manhole covers and frames.
IS : 1742	Code of practice for building drainage.
IS : 2064	Selection, installation and maintenance of sanitary appliance code of practice.
IS : 2065	Code of practice for water supply in buildings.
IS : 2104	Specification for water meter for boxes (domestic type)
IS : 2379	Colour code for identification of pipe lines.
IS : 2527	Code of practice for fixing rainwater gutters and down pipes for roof drainage.
IS : 2629	Recommended practice for hot dip galvanizing on iron and Steel.
IS : 3114	Code of practice for laying of cast iron pipe
IS : 4111 (Part 1)	Code of practice for ancillary structures in sewerage system: Part 1 manholes.
IS : 4127	Code of practice for laying glazed stoneware pipes.

IS : 5329	Code of practice for sanitary pipe work above ground for buildings.
IS : 6159	Recommended practice for design and fabrication of material, prior to galvanizing.
IS : 7558	Code of practice for domestic hot water installations.
IS : 8321	Glossary of terms applicable to plumbing work.
IS : 8419 (Part 1)	Requirements for water filtration equipment: Part 1 Filtration medium sand and gravel.
IS : 9668	Code of practice for provision and maintenance of water supplies and fire fighting.
IS : 9912	Coal tar based coating materials and suitable primers for protecting iron and steel pipe lines.
IS : 10221	Code of practice for coating and wrapping of underground mild steel pipelines.
IS : 10446	Glossary of terms relating to water supply and sanitation.
IS : 11149	Rubber Gaskets
IS : 12183 (Part 1)	Code of practice for plumbing in multistoried buildings: Part 1 water supply.
IS : 12251	Code of practice for drainage of building basements.
IS : 5572	Code of practice for sanitary pipe work.
BS : 6700	Specification for design, installation, testing and maintenance of services supplying water for domestic use within buildings and their cartilages.
BS : 8301	Code of practice for building drainage.

2. <u>Pipes and Fittings</u>

IS : 458	Specification for precast concrete pipes (with and without reinforcement)
IS : 651	Stone ware pipes
IS : 1239 (Part 1)	Mild steel, tubes, tubulars and other wrought steel fittings: Part 1 Mild Steel tubes.
IS : 1239 (Part 2)	Mild Steel tubes, tubulars and other wrought steel fittings: Part 2 Mild Steel tubulars and other wrought steel pipe fittings.
IS : 1536	Centrifugally cast (spun) iron pressure pipes for water, gas and

	sewage.
IS : 1537	Vertically cast iron pressure pipes for water, gas and sewage.
IS : 1538	Cast Iron fittings for pressure pipes for water, gas and sewage.
IS : 1729	Sand Cast iron spigot and socket soil, waste and ventilating pipes, fittings and accessories.
IS : 1879	Malleable cast iron pipe fittings.
IS : 3989	Centrifugally cast (sun) iron spigot and socket soil, waste and ventilating pipes, fittings and accessories.
IS : 4346	Specifications for washers for use with fittings for water services.
IS : 4711	Methods for sampling steel pipes, tubes and fittings.
IS : 6392	Steel pipe flanges
IS : 6418	Cast iron and malleable cast iron flanges for general engineering purposes.
IS : 7181	Specification for horizontally cast iron double flanged pipe for water, gas and sewage.

3. <u>Valves</u>

IS : 778	Specification for copper alloy gage, globe and check valves for water works purposes.
IS : 780	Specification for sluice valves for water works purposes (50 mm to 300 mm size).
IS : 1703	Specification copper alloy float valves (horizontal plunger type) for water supply fittings.
IS : 5312 (Part 1)	Specification for swing check type reflux (non return) valves : part 2 Multi door pattern.
IS : 5312 (Part 2)	Specification for swing check type reflux (non return) valves : part 2 Multi door pattern.
IS : 12992 (Part 1)	Safety relief valves, spring loaded : Design
IS : 13095	Butterfly valves for general purposes.

4. Water Quality Tolerance

IS : 3025 (Parts 1 to	Method of sampling and test (physical and chemical)

44)	for water and waste water.

IS : 4764	Tolerance limits for sewage effluents discharged into inland surface waters.
IS : 10500	Drinking Water

5. <u>Pumps & Vessels</u>

IS : 1520	Specification for horizontal centrifugal pumps for clear cold fresh water.
IS : 2002	Steel plates for pressure vessels for intermediate and high temperature service including boilers.
IS : 5600	Specification for sewage and drainage pumps
IS : 8034	Specification for submersible pump sets for clear, cold, fresh water.
IS : 8418	Specification for horizontal centrifugal self priming pumps.

SECTION – 7 - SPECIFICATION FOR ELECTRICAL WORK AND INSTRUMENTATION

1. Work under this section shall consist of providing detailed designing, labour, materials and equipment necessary and required to provide all electrical equipment for the treatment plant.

   Without restricting to the generality of the foregoing the electrical installation work shall consist of:-

1.1 Electric motors for all equipment.

1.2 Cabling to all electrical motors.

1.3 Wiring for pumping station and control room.

1.3 Motor control centre

1.5 Instrumentation

1.6 Internal electrification of all pumps/control rotors.

2. GENERAL

2.1 All electrical motors and other equipment shall be suitable for 415 ± 10% volts, 3 phase, 50 cycles. Motor 1 H.P. or below shall be single phase. All motors installed in open area must have space heaters and the circuits should have provision for automated operation.

2.2 All motors shall be rated 10.0% above the required H.P.

2.3 Each motor shall be provided with weather proof terminal box and motors in exposed conditions shall be provided with suitable removable PVC covers.

2.4 Connections to all motors shall be made with flexible connections with suitable bushes and terminal lugs.

2.5 All electrical equipment supplied shall conform to relevant Indian or British standards wherever applicable and of reputed makes. **All items shall be tested at manufacturer's** works and certified copies of such tests shall be upplied to the owners.

2.6 All electrical work shall be executed by authorized and qualified persons competent to undertake such works under the rules and regulations of the local electric supply authority.

3. MOTORS

3.1 Electric motors shall be totally enclosed fan cooled induction type squirrel cage motors conforming to I.S. 325.

4. GENERAL SPECIFICATION FOR ELECTRICAL PANEL

CONSTRUCTION FEATURES:

GENERAL:

4.1 Electrical Panel shall be fabricated out of CRCA sheet steel cubicle, indoor floor mounting, dead front freestanding type. The design shall be totally enclosed, completely dust tight and vermin proof. The sheet steel used shall be 16 SWG thick, gaskets of 2mm thick shall be used between all adjacent units and beneath all covers to render the joints effectively dust proof. Sheet steel work shall be of high quality. All openings and outlets in the doors shall be machine made and shall be free from burrs. Welded runs shall be ground smooth. All sheet surfaces shall be free from dents and hammer marks. A base channel of 100mm x 50mm fabricated out of 3mm thick hot rolled sheet steel painted black shall be provided to prevent corrosion of the sheet steel cubicles and to facilitate cleaning of floors. For convenience of operation and ease of cable termination, there shall be a gap of at least 150 mm between the floor level and the bottom most unit.

4.2 The design of framework and end covers shall be such as to require a minimum number of screws visible from outside. The frame work shall be made of steel sheets folded to impart strength which will also serve as continuous barriers between logically arranged switch board components. The arrangement of horizontal and vertical bus bars, switchgear compartment and cable space shall be used on modular construction.

4.3 Each module shall be fitted with individual dust proof doors provided with insulated thumbscrews. The switchboard shall have uniform height And depth throughout its length and shall present a flush app earance. The maximum operation height shall not exceed 2000mm. Adequate lifting facilities shall be provided for each shipping section to facilitate handling and transport. The compartment doors shall be so inter locked that it shall not be possible to open the doors with the switch in closed position. An arrangement for defeating this door inter lock shall be provided for testing purposes.

4.4 Outgoing links from feeders shall be rigidly supported and suitably extended in cable box chamber for ease of cable connections. Insulated shields shall cover Cable lugs and links. Barriers shall be provided between the modules accommodating equipments associated with the outgoing circuits. All vertical sections shall have covering at the bottom so that entry of dust, rats and vermin is not possible.

5. MCCB COMPARTMENT:

The MCCB shall be of the air break type in order to eliminate fire and explosion risk. The compartment doors should be so inter locked that they do not open when the MCCB is in closed position. The MCCBs shall have rupturing capacity of 25 KA.

6. BUS BARS:

Three phase & neutral Al. bus bars shall be provided of rating as specified. Al. alloy used for bus bars and connections shall be equivalent to E.91-E-WP of I.S.5082/1969. Busbars shall be housed in separate busbar chambers. The

busbars shall be suitably braced to with stand the fault level and shall be supported on unbreakable non-hygroscopic fingered/SMC type insulators rigidly held to the framework of the chamber. Busbar chamber shall have a separate screwed cover and means shall be provided to identify the various phases of the busbars.

7. CABLE COMPARTMENTS:

A full height cable compartment shall be provided for easy termination of all incoming and outgoing cables entering either from top or from bottom. Adequate supports shall be provided for the cables where necessary. The cable compartment shall have it's own hinged cover which can be removed for case of access during cabling.

8. INTER CONNECTION AND CONTROL WIRING:

Switch board shall be completely factory wired ready for connecting to the equipment. Power connection of the circuits shall be done by Al. flats or by adequate size of P.V.C. insulated standard copper wires. Control wiring shall be done by P.V.C. insulated wires of minimum size 1.5 Sq.mm copper. All control wiring shall be fitted with identification ferrule at each end and not more than two connections shall be made at any one terminal. The wires shall be arranged and supported in such a manner that there shall be no strain on the terminations.

9. TERMINAL ARRANGEMENTS:

The termination shall be of adequate current rating and size to suit individual feeder requirements. For connections above 63 amps .rating cable lugs shall be used. These cable lugs shall be mounted in such a manner so as to facilitate easy cable connections. Terminals shall be mounted in the cable compartment.

Tap off connections at the busbar shall be made with nuts, bolts and washers. Busbars shall not be threaded for terminating wire connections.

10. CABLE ENTRY:

The switchboard shall be designed to facilitate for termination of incoming and outgoing Al. conductor P.V.C. cable from top and/or bottom as the case may be. Removable sheet steel plates provided with suitable size of cable glands as specified shall be fitted at the top/bottom.

11. INDICATION INSTRUMENTS:

The indicating instruments shall be of a reputed make conforming to relevant I.S. The arrangement of the instruments shall be logical. The size of the instruments shall be 96 mm x 96 mm.

12. LABLES: Engraved P.V.C. labels shall be provided on all the incoming and outgoing feeder compartments. The exact legend to be engraved will be furnished by the Department.

13. EARTHING BUS BARS:

The earth busbars shall be copper and size 25mm x 3mm minimum and should run throughout.

The length of panel and earth studs is to be provided at both ends.

14. PAINTING: All steel work shall undergo a process of degreasing, pickling in acid, cold rinsing, phosphating, passivating and then powder coated with approved colour.

15. CABLING

15.1 Contractor shall supply install and commission all cables from the M.C.C. panel to each motor. Underground cables shall be laid to a minimum depth of 900 cms. and shall be protected with sand and bricks on top. Cables running on surfaces shall be neatly clipped to aluminium saddles at suitable intervals.

15.2 All cables shall be PVC sheathed cables of 1100 volts grade conforming to I.S: 1554 part-I. All cabling work shall be as per standard practice in accordance with i.e. rules.

16. Approval

16.1. Contractor shall comply with the provisions of Govt. acts regulations and bylaws of local authorities and any other competent authority to whose supply the proposed installation is to be connected.

16.2 Contractor shall obtain all the necessary permits. He shall be responsible for submitting all tests reports; application forms payments of fees etc.

17. INSTRUMENTATION

17.1 Contractor shall provide, install and commission instrumentation system / equipments wherever found desirable for the proper and efficient functioning of the Effluent Treatment Plant. All instruments shall be of heavy-duty type and resistant to corrosion and suitable for outdoor installation.

17.2 METERING INSTRUMENTS

17.2.1 Provide one float operated venturi flume type rate of flow meter at grit chamber inlet with calibrations in cum/hr. or litres/min.

17.2.2 Provide one bulk flow meter (in chased type) for measurement of final effluent.

17.2.3 All pumps shall be provided with Bourden type pressure gauge calibrated in kg./sq. cm. each pressure gauge shall be provided with one gunmetal isolation cock.

SECTION – 8 :: 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 preforming 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 & rotameters. 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 pipework 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.

· 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.

d. Check all clamps, supports and hangers provided for the pipes.

e. 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.

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	Drinking Water (All cold water lines after filter)	Sea Green	French Blue	Single Red
2	Treated Water (Soft Water)	Sea Green	Light Orange	
3	Domestic Hot Water	Sea Green	Light Grey	
4	Drainage	Black		

Colour Code to Conform to IS:2379:1990

TECHNICAL SPECIFICATIONS
SECTION – 1

GENERAL AND COMMERCIAL

1.0 SCOPE:

(i) These General Specifications indicate the requirements and precautions to be taken during the execution of Internal Electrical Installation works to ensure efficient, safe, economical and practical use of materials and equipments including prevention of risks and fire hazards.

(ii) This Chapter also covers the general commercial requirements applicable to this works contracts for Electrical Installation works.

1.1 RELATED DOCUMENTS:

(i) These General Specifications shall be read in conjunction with the standard conditions of contract contained in other parts of the document and their correction slips, the tender specifications, schedule of quantities, drawings and other documents in the tender papers connected with this work.

1.2 WORKS INCLUDED IN THIS SECTION:

(i) 230V single phase, 2 wire and 400V 3phase 4 wire Power distribution system complete.

(ii) An adequate equipment grounding system.

(iii) Providing & fixing of distribution boards.

(iv) Fixing of luminaries and fans.

(v) Conduit with wires for Communication System.

(vi) Providing & Installing LT Panel

(vii) Providing & fixing of cables etc.

(viii) Automatic Fire Alarm and Detection System.

1.3 INTEREPRETATION OF AGREEMENT:

In the interpretation of the agreement, the order of descending importance for any ambiguity or discrepancy shall be as follows;-

- Schedule of Quantities
- Technical Specifications.
- Special Conditions
- Drawings.
- I.S.I. Codes/National Electrical Code/ latest CPWD Specifications/ B.S.S./ or any other International Standard.
- Clauses of Contract.
- General Directions.
- Sound Engineering practice.

1.4 DRAWINGS:

1.4.1 CONTRACT DRAWINGS:

Contract drawings are basic but shall be closely followed as actual construction permits. Any deviations made shall be in conformity with the Architectural and other services drawings. Shop drawings shall be submitted by the contractor and got approved from the consultants. Architectural drawings shall take precedence over contract or other services drawings as to all dimensi**ons. Any deviations in drawings will be brought to consultant's** Notice before work is executed as directed by consultants. Contractor shall verify all dimensions at site and bring to the notice of the consultants any or all discrepancy or deviations noticed.

1.4.2 DETAILED WORKING DRAWINGS:

Detailed working drawings and detail drawings on the basis of which actual work is to be proceeded will be furnished to the contractor by the consultants from time to time. Variation of any nature from those indicated in the drawings made available to him at the tender stage which are as `Advance Drawings' as a guide to generally describe the scheme will not entitle the contractor for claiming any additional payment, payments will be made on the actual measurement of the work done, as admissible, as per drawings, at the accepted rates entered in the Schedule of Quantities forming part of this tender document.

1.4.3 PREPARATION OF SHOP AND FABRICATION DRAWINGS:

All shop and fabrication drawings shall be prepared by Contractor based on the Consultant's drawing and got approved from the consultants. No extra payment shall be admissible to the contractor on this account.

1.4.4 SHOP DRAWING, MAINTENANCE MANUALS Etc.:

On the award of the work, the contractor shall immediately proceed with the preparation of detailed shop drawings, detailing the equipment that are to be installed and the ancillary works that are to be carried out. Six sets of all such working drawings shall be submitted to the consultants for their approval to ensure that the works will be carried out in accordance with the specifications and drawings, including such changes as may have been mutually agreed upon. The basic drawings shall be received by the consultants for his approval within two weeks of the award of work, and complete shop/detail drawings within four weeks of award of work.

1.4.5 Any drawing issued by the consultants for the work are the property of the consultants and shall not be lent, reproduced or used on any works other than intended without the written permission of the consultants.

1.4.6 The contractor shall provide the following drawings for approval to consultants before commencement of supply/fabrication.

1.4.6.1 L.T. Panels

(i) General layout-Plan, section, elevations
(ii) Foundation
(iii) Wiring-Power & Controls

1.4.6.2 Distribution Boards

(i) General layout-Plan, section, elevations
(ii) Foundation/Fixing arrangement.
(iii) Wiring-Power & Control

1.4.6.3 Internal Electrification System:

(i) Conduit Lay-out with number and size of wires in it for various outlets.
(ii) Details of Switch Boxes

1.4.6.4 Cable Routing and Earthing System:

(i) General Cable layout-Plan with sizes of Cable and Cable Trays at different floor & in Substation area.
(iii) Details of Earthing strip sizes & connections

1.4.6.5 All drawings as indicated in various sub-heads.

1.5 After completion of the work the contractor shall submit one original on R.T.F & three prints of as built drawings along with compact disc/s (CD.s/DVD.s) containing the same before the certificate of completion is issued to him. These drawing would include;

(i) The location of all the equipment supplied & erected by the contractor.
(ii) Cable routes clearly indicating the sizes & number of cables.
(iii) Earthing layout - indicating the type of earth station & size of earth conductor.
(iv) Wiring diagram of L.T. Panels.
(v) Complete single line diagram for Normal and Emergency supplies.
(vi) Any other information the consultants may deem fit.

1.6 APPROVALS:

1.6.1 The contractor shall obtain all information relating to local regulations, Bye-Laws, sanction and release of electrical connection, application of any and all laws relating to his work or profession and his having to execute work as required. No additional claims shall be admissible on this account.

1.6.2 Contractor shall obtain approval of the installation from the relevant inspection/ sanctioning Authorities at all stages and on completion of the installation work. The Contractor shall also get the required electrical load sanctioned and released from the concerned authorities and nothing extra shall be paid for the same except for the money for which the contractor produces valid receipts from the Govt. departments. The contractor shall pass on these approvals to the consultants. The rates quoted by the contractor for various items of the work shall be deemed to include any money payable to the Government/ Local Authorities/Statutory Bodies/Electrical Inspectorate for obtaining approvals and nothing extra shall be paid to the contractor on this account except for the money foe which proper receipts are submitted by the contractor to the consultants.

1.7 CODE REQUIREMENTS:

All work shall be done in accordance with the I S S Code amended upto date/ Indian Electricity Rules.

1.8 MATERIALS:

All materials to be used in this work be new and bear the consultant's label of approval.

1.9 RATES:

(i) The work shall be treated as on works contract basis and the rates tendered shall be for complete items of work inclusive of all taxes (including works contract tax, service tax VAT if any), duties, and levies etc. and all charges for items contingent to the work, such as, packing, forwarding, insurance, freight and delivery at site for the materials to be supplied by the contractor, watch and ward of all materials for the Internal E.I. work at site etc.

(ii) Prices quoted shall remain firm during the prevalence of the project.

1.10 TAXES AND DUTIES:

(i) Being an indivisible works contract, sales tax, VAT, excise duty, service tax etc. are not payable separately.

(ii) Works contract tax, if any, for the work shall be included within the quoted rates for the various items. The works contract tax shall be deducted from the bills of the contractor, as applicable.

(iii) Octroi duty shall not be paid separately for the materials supplied by the contractor.

1.11 COMPLETENESS OF TENDER:

All sundry fittings, assemblies, accessories, hardware items, foundation bolts, termination lugs for electrical connections as required, and all other sundry items which are useful and necessary for proper assembly and efficient working of the various components of the work shall be deemed to have been included in the tender, whether such items are specifically mentioned in the tender documents or not.

1.12 WORKS TO BE DONE BY THE CONTRACTOR:

(i) Unless and otherwise mentioned in the tender documents, the following works shall be done by the contractor, and therefore their cost shall be deemed to be included in their tendered cost:-

(ii) Cutting and making good all damages caused during installation and restoring the same to their original finish.

(iii) Painting at site of all exposed metal surfaces of the installation other than pre-painted items like fittings, fans, switchgear/ distribution gear items, etc. Damages to finished surfaces of these items while handling and erection, shall however be rectified to the satisfaction of the consultants.

(vi) Temporary shed if required over the storage space and locking arrangement thereof, and watch and ward of the materials and completed installation till completion of the work.

(v) Testing and commissioning of completed installation.

1.13 TOOLS FOR HANDLING AND ERECTION:

All tools and tackles required for handling of equipments and materials at site of work as well as for their assembly and erection and also necessary test instruments shall be the responsibility of the contractor.

1.14 CARE OF THE BUILDING:

Care shall be taken by the contractor to avoid damage to the building during execution of his part of the work. He shall be responsible for repairing all damages and restoring the same to their original finish at his cost. He shall also remove at his cost all unwanted and waste materials arising out of his work from the site.

1.15 STRUCTURAL ALTERATIONS TO BUILDING

(i) No structural member in the building shall be damaged /altered, without prior approval from the consultants.

(ii) Structural provisions like openings, cutouts, if any, provided for the work, shall be used. Where these require modifications, or where fresh provisions are required to be made, such contingent works shall be carried out by the contractor at his cost with prior approval of the consultants.

(iii) All chases required in connection with the electrical works shall be provided and filled by the contractor at his own cost to the original architectural finish of the buildings.

SECTION – 2

LT CABLES:-

1. MEDIUM AND LOW PRESSURE:

Cables should be steel armoured XLPE insulated PVC sheathed with fire retardant compound Aluminium conductor conforming to the quality as specified in the schedule of work. All cables, accessories and other materials should conform to I S Specification. The jointing work should be carried out by a competent authorised cable jointer.

2. LAYING OF CABLES:

All cables shall be laid as per C.P.W.D GENERAL SPECIFICATIONS FOR ELECTRICAL WORKS (PART-II EXTERNAL) - 2005 with all upto date amendments.

3. TESTING THE CABLES:

All cables shall be tested as per C.P.W.D GENERAL SPECIFICATIONS FOR ELECTRICAL WORKS (PART-II EXTERNAL) - 2005 with all upto date amendments.

SECTION – 3

TECHNICAL REQUIREMENTS & MEASUREMENT SYSTEM

1.0 SCOPE

This chapter covers the general technical requirements and measurement system of the various components in Internal Electrical Installation works.

1.1 TERMINOLOGY

1.1.1 The definition of terms shall be in accordance with IS:732-1989 (Indian Standard Code of Practice for Electrical Wiring), except for the definitions of point, circuit, and sub-main wiring, which are defined in clauses 2.2.1, 2.3.1, and 2.3.2 hereunder.

1.2 POINT WIRING

1.2.1 Definition

A point (other than socket outlet point) shall include all work necessary in complete wiring to the following outlets from the controlling switch or MCB. The scope of wiring for a point shall, however, include the wiring work necessary in tapping from another point in the same distribution circuit.

Ceiling rose or screwless connector (in the case of points for ceiling/exhaust fan points, pre-wired light fittings, and call bells).

Ceiling rose (in the case of pendants except stiff pendants).

Back plate (in the case of stiff pendants).

Lamp holder (in the case of goose neck type wall brackets, batten holders and fittings which are not pre-wired) .

Note: - In the case of call bell points, the words "from the controlling switch or MCB" shall **be read as "from** the ceiling rose/connector meant for connection to bell push".

1.2.2 Scope

Following shall be deemed to be included in point wiring.

Conduit, accessories for the same and wiring cables between the switch box and the point outlet.

All fixing accessories such as screws, rawl plug etc. as required.

Metal switch boxes for control switches, regulators, sockets etc, recessed in walls.

Outlet boxes, junction boxes, pull-through boxes etc, including metal boxes if any, provided with switch boards for loose wires/conduit terminations. Control switch or MCB, as specified.

Ceiling rose or connector as required.

Connections to ceiling rose, connector, socket outlet, lamp holder, switch etc.

Interconnecting wiring between points on the same circuit, in the same switch box or from another.

Protective (loop earthing) conductor from one metallic switch box to another in the distribution circuits, and for socket outlets. (The length of protective conductor run along with the circuits is included in the scope of points).

The circuit wiring in conduit and wiring between various switches/switch boxes on the same circuit.

1.2.3 Measurement:

1.2.3.1 Point Wiring:

Unless and otherwise specified , there shall be no linear measurement for point wiring for light points, fan points, exhaust fan points, 5/6amp plug points, 15/16 amp. plug points and call bell points.

These shall be measured on unit basis by counting only.

No separate measurement will be made for interconnections between points in the same distribution circuit and for the circuit wiring including protective (loop earthing) conductors between metallic switch boxes.

1.2.3.2 Point wiring for socket outlet points:

The light plug (6A) point and power 16A) point wiring shall be measured as indicated above.

The metal box with cover, switch/MCB ,socket outlet and other accessories shall be measured and paid as a part of the item only.

The power point outlet may be 16A/6 A six pin socket outlet, where so specified in the tender documents.

1.2.3.3 Group control points wiring:

In the case of points with more than one point controlled by the same switch, such points shall be measured in parts i.e.(a) from the switch to the first point outlet as primary point and for the subsequent points, the distance from that outlet to the next one and so on, shall be treated as secondary point(s).

The switch for controlling four or more outlets shall be of 16 amp. rating and no extra payment shall be made for the same.

No recovery shall be made for non-provision of more than one switch in such cases.

1.2.3.4 Twin control light points wiring:

A light point controlled by two numbers of two way switches shall be measured as two points from the fitting to the switches on either side.

No recovery shall be made for non-provision of more than one ceiling rose or connector in such cases.

1.3 CIRCUIT AND SUBMAIN WIRING

1.3.1 Circuit wiring

Circuit wiring shall mean the wiring from the distribution board upto the tapping point for the nearest first point of that distribution circuit, viz. upto the nearest first switch box. No measurement/ extra payment shall be made for circuit wiring.

1.3.2 Submain wiring

Submain wiring shall mean the wiring from one main/distribution switchboard to another.

1.3.3 Measurement of submain wiring

The sub main wiring shall be measured on linear basis and paid for separately.

1.4. OTHER WIRING WORKS:

Except as specified above for point wiring, circuit wiring and submain wiring, other types of wiring shall be measured separtely on linear basis along the run of wiring depending on the actual number and sizes of wires run.

1.5 SYSTEM OF DISTRIBUTION AND WIRING:

1.5.1. Control at the point of entry of supply

There shall be a circuit breaker on each live conductor of the supply mains at the point of entry.

1.5.2 Distribution:

The wiring shall be done on a distribution system through main and/or branch distribution boards. The system design as well as the locations of boards shall be as indicated in BOQ/drawings or as specified by the consultants.

Main distribution board shall be controlled by a circuit breaker. Each outgoing circuit shall also be controlled by a circuit breaker.

The branch distribution board shall be controlled by a circuit breaker. Each outgoing circuit shall be provided with a miniature circuit breaker (MCB) of specified rating on the phase or live conductor.

The loads of the circuits shall be divided, as far as possible, evenly between the number of ways of the distribution boards, leaving at least one spare circuit for future extension.

The neutral conductors (incoming and outgoing) shall be connected to a common link (multiway connector) in the distribution board and be capable of being disconnected individually for testing purposes.

`Power' wiring shall be kept separate and distinct from `Lighting' wiring, from the level of circuits i.e., beyond the branch distribution boards.

Wiring shall be separate for essential loads (i.e., those fed through standby supply) and non essential loads throughout.

1.5.3. Balancing of Circuits:

The balancing of circuits in three wire or poly phase installations shall be arranged before hand to the satisfaction of the consultants.

1.5.4 Wiring System:

Wiring shall be done only by the "Looping system". Phase or live conductors shall be looped at the switch boxes and neutral conductors at the point outlets.

Lights, fans and call bells shall be wired in the `lighting' circuits. 15A/16A socket outlets and other power outlets shall be wired in the 'Power' circuits. 5A/6A socket outlets shall be **wired in the 'lighting' circuits.**

The wiring throughout the installation shall be such that there is no break in the neutral wire except in the form of a linked switchgear.

1.5.5 Run of Wiring:

The wiring shall be in recessed/surface PVC conduit.

Due consideration shall be given for neatness, good appearance and safety.

1.5.6 Passing through walls or floors:

When wiring cables are to pass through a wall, these shall be taken through a protection (steel) pipe tube of suitable size such that they pass through in a straight line without twist or cross in them on either end of such holes. The ends of metallic pipe shall be neatly bushed with porcelain, PVC or other approved material.

All floor openings for carrying any wiring shall be suitably sealed after installation.

1.6 Joints in wiring:

No bare conductor in phase and/or neutral or twisted joints in phase, neutral, and/or protective conductors in wiring shall be permitted.

There shall be no joints in the through-runs of cables. If the length of final circuit or submain is more than the length of a standard coil, thus necessitating a through joint, such joints shall be made by means of approved mechanical connectors in suitable junction boxes.

Termination of multistranded conductors shall be done using suitable crimping type thimbles.

1.7 RATINGS OF OUTLETS:

Incandescent lamps shall be rated at 100W.

Ceiling fans shall be rated at 80W. Exhaust fan, fluorescent tubes, compact fluorescent tubes, HPMV lamps, HPSV lamps etc. shall be rated according to their capacity. Control gear losses shall be also considered as applicable.

5A/6A and 15A/16A socket outlet points shall be rated at 100 W and 500 W respectively, unless the actual values of loads are specified.

1.8 CAPACITY OF CIRCUITS:

`Lighting' circuit shall not have more than a total of 10 points of light, fan and socket outlets, or a total connected load of 800W, whichever is less.

`Power' circuit shall have only two outlet per circuit.

1.9 CONFORMITY TO IE ACT, IE RULES, AND STANDARDS:

All electrical works shall be carried out in accordance with the provisions of Indian Electricity Act, 1910 and Indian Electricity Rules, 1956 amended upto date. List of Rules of particular importance to building installations is given in Appendix for reference.

The works shall also conform to relevant Indian Standard Codes of Practice (COP) for the type of work involved.(See Appendix B).

In all electrical installation works, relevant safety codes of practice shall be followed.
Guidelines on safety procedure outlined in Appendix `C' should be adopted.

1.10 GENERAL REQUIREMENTS OF COMPONENTS:

1.10.1 Quality of materials:

All materials and equipments supplied by the contractor shall be new. They shall be of such design, size and material as to satisfactorily function under the rated conditions of operation and to withstand the environmental conditions at site.

1.10.2 Ratings of components

All components in a wiring installation shall be of appropriate ratings of voltage, current, and frequency, as indicated in BOQ.

All conductors, switches and accessories shall be of such size as indicated in BOQ.

1.10.3 Conformity to Standards

All components shall conform to relevant Indian Standard Specification, wherever existing. Materials with ISI certification mark shall be preferred.

A broad list of relevant Indian Standards is given in Appendix `A'. These Indian Standards, including amendments or revisions thereof upto the date of tender acceptance, shall be applicable in the respective contracts.

1.10.4 Interchangeability

Similar parts of all switches, lamp holders, distribution boards, switchgears, ceiling roses, brackets, pendants, fans and all other fittings of the same type shall be interchangeable in each installation.

1.11 CABLES:

1.11.1 Wiring cables

Conductors of wiring cables shall be of copper. The wiring cables shall be of certified FRLS type.

The smallest size of conductor for `lighting' circuits shall have a nominal cross sectional area of not less than 1.5 sq mm. The minimum size of conductor for 'power' wiring shall be 4 sq mm.

1.12 WIRING ACCESSORIES

1.12.1 Control switches for points

Control switches (single pole switches) carrying not more than 16A shall be of clamp on type complete with plate, as specified, and the switch shall be "ON" when the knob is down.

The type and current rating of switch controlling a group of points, or discharge lamps, or a single large load, shall be specified in the tender documents.

Control switch shall be placed only in the live conductor of the circuit. No single pole switch or fuse shall be inserted in the protective (earth) conductor, or earthed neutral conductor of the circuit.

1.12.2 Socket outlets

Socket outlets shall also be of clamp on type complete with plate. These shall be rated either for 5A/6A, or 15A/16A. Combined 5A/15A, or 6A/16A six pin socket outlet shall be provided in `power' circuits wherever specified.

Socket outlets and plugs shall only be of 3 pin type; the third pin shall be connected to earth through protective (loop earthing) conductor. 2 pin or 5 pin sockets shall not be permitted to be used.
The control switches for the 5A/6A and 15A/16A socket outlets shall be kept alongwith the socket outlets.

1.12.3 Switch box covers

These shall be moulded type of suitable size.

1.12.4 Lamp holders

Lamp holders may be of batten, angle, pendant or bracket holder type as indicated in BOQ. The holder shall be made of brass and shall be rigid enough to maintain shape on application of a nominal external pressure. There should be sufficient threading for fixing the base to the lamp holder part so that they do not open out during attention to the lamp or shade.

Lamp holders for use on brackets and the like shall have not less than 1.3 cm nipple, and all those for use with flexible pendant shall be provided with cord grips.

All lamp holders shall be provided with shade carriers.

1.13 FITTINGS:

1.13.1 Types:

The type of fittings shall be as specified in BOQ.

1.13.2 Indoor type fittings

The conductors are required to be drawn through tube popularly known as conduit. The tube or channel must be free from sharp angles or projecting edge, and of such size as will enable them to be wired with the conductors used for the final circuit without removing the braiding or sheathing. As far as possible all such tubes or channels should be of sufficient size to permit looping back.

Fittings using discharge lamps shall be complete with power factor correction capacitors, either integrally or externally. An earth terminal with suitable marking shall be provided for each fitting for discharge lamps.

1.14 SWITCHGEAR AND CONTROL GEAR - General aspects:

All items of switchgear and distribution boards (DBs) shall be metal clad type.

The types, ratings and/or categories of switchgear and protective gear shall be as specified in the BOQ.

RCBs (ELCBs) where specified, shall conform to the requirements of current rating, fault rating, single phase or three phase configuration and sensitivity laid down in the BOQ.

While each outgoing way of distribution board (DB) shall be of miniature circuit breaker (MCB) as specified, and of suitable rating on the phase conductor, the corresponding earthed neutral conductor shall be connected to a common neutral terminal block and shall be capable of being disconnected individually for testing purposes.

(i) Independent earth terminal block:

Every distribution board (single phase as well as 3 phase) shall have an earth terminal block identical to, but independent from neutral terminal block, to enable termination of protective (loop earthing) conductors (incoming as well as outgoings) individually by screwed connection and without twisting.

Earthing terminal (1 for single phase and 2 for 3 phase) shall be provided on the metal cladding of switches and DBs for body earthing. These shall be suitably marked. Knock out holes, with or without end plates as per standard design of manufacturers, shall be provided in the metal cladding of switches and DBs for termination of conduits/cables.

1.15 PRE-WIRED MCB DISTRIBUTION BOARDS:

Prewired MCB DBs shall be provided only where specified.

All final Distribution Boards (hereafter will be referred as DBs) shall be selected from the same range, based on installation requirement. Irrespective of the installation method (flush or surface mounted), they shall designed and manufactured as per Indian Standard IS8623-1 and 3

The Distribution Board shall be made of CRCA Sheet Steel. It shall be powder coated with dust/dirt repellent white colour (Powder coating thickness shall be minimum 60 to 100 m on all the plane surfaces) after ten tank process. Exude

The Ingress Protection for entire range of DBs must be certified by any neutral testing authority (viz. ERDA or CPRI) as per standard **IS/IEC 60529** for the degree of;

- IP30 for DBs with Single Door
- IP43 for DBs with Double Door with EPDM (Ethylene Propylene Diene Monomer) Gasket

The Impact Protection for entire range of DBs must be certified by any neutral testing authority (viz. ERDA or CPRI) as per standard **IEC 62262** for the degree of;

- IK08 for DBs with Single Door
- IK09 for DBs with Double Door

The supplier must submit the test report for IP and IK testing by neutral testing authority (viz. ERDA or CPRI) as per above mentioned standards.

For internal connections DBs shall be supplied with suitably rated colour coded FRLS wire set with Pin type lugs on both the ends.

DBs shall be supplied with 100A rated Insulated Busbars made of Copper with Tin plating to avoid copper oxidation.

DBs shall be provided with Side mounted shrouded & isolated 100A rated Brass Neutral Bars. Neutral Bar shall be fastened on the U-box.

The DIN rail shall be Zinc plated and must not have any injurious sharp corners. DIN rail shall be provided with MCB stopper arrangement in order to achieve the comfort in centre plate assembly. All the TPN DBs shall be provided with removable DIN rail chassis.

DBs shall be provided with rotary knob and shall have flexibility to change to Key lock on field.

DBs shall be provided with removable Gland plates on top and bottom with adequate numbers of knock-out holes of appropriate size and mounted on DB with minimal possible screws to save installation time.

Neutral Terminator shall be provided to terminate the Incoming Neutral in case of 3P MCCB incomer DBs.

DB shall be provided with door earthing.

Centre plate of double door DB, shall be provided with installer friendly plastic stud for safe and ease of removal from U-box.

DB shall have adaptability to upgrade to IP43 from IP30 post installation, as well.

DB shall have all standard/common combi-head screws for Frame and Centre plate assembly.

In case of IP43 DBs, door shall be reversible to have flexibility to open from either side.

TPN DBs shall be ready to upgrade to Per Phase Isolation DB configuration, so as to give better continuity of supply and only respective phase isolation in case of earth fault on any phase.

The DBs shall have two nos. of external Earth Stud to ensure better Earth continuity and shall have embossed earthing symbol for easy identification.

DB shall be able to accommodate all types of Modular devices viz. Protection Devices (MCBs, RCDs, SPDs, Auxiliaries), Controlling Devices (Isolators, Changeover switches, Contactors, Impulse Relays, Push Buttons) and Indication Devices (Indicators, Meters etc.).

Cement spill protector shall be provided with the double door DBs, so as to avoid entry of dust & dirt at the time of the civil work. Also, full length plastering guide shall be provided to help ease and correct levelling of plaster along the DB sides.

DB shall be provided with 5 holes (1 key hole for DB positioning and 4 nos capsule holes for DB fixing) for ease mounting on wall.

DB shall comply with RoHS and REACH standard and shall have high Strength-to-Weight ratio to avoid burden on building structure.

1.16 MINIATURE CIRCUIT BREAKERS (MCB's):

Miniature circuit breakers shall be of approved design and make and must be tested and validated as per IS/IEC 60898, IEC/EN 60898 and IEC 60947-2 standards.

MCBs shall be suitable for operation at 230V/415V, 50Hz supply. The MCB ratings shall be available from 1--125A in 1P/2P/3P/4P versions. The rated short circuit capacity acc to IS/IEC 60898 shall be of 10,000A. MCBs shall be offered with B, C or D tripping characteristics as per the BOQ requirements. The MCBs shall be suitable for mounting on a 35mm DIN rail.

MCBs shall carry ISI and CE marking. The MCB manufacturer (through the bidder) has to submit the valid BIS license certificate at the time of offer submission.

MCBs shall ensure complete electrical Isolation of downstream circuit or equipment, when the MCB is switched OFF (to be marked on the MCB in symbolic form)

IP 20 Degree of Protection shall be ensured to prevent electrical shocks by accidental touch to any live parts, by providing finger touch proof terminals.

Energy Limitation Class-3 shall be to ensure minimum let through energy in the event of a fault, for safety & longevity of downstream circuit equipment. (to be mentioned on the MCB as per standards)

MCBs shall be line-load reversible with no derating.

MCBs shall have bi-connect facility to terminate fork type busbar and wires, simultaneously. Terminal capacity shall be minimum 25 sq.mm. for ratings up to 25A, and 35 sq.mm. for ratings 32A & above to ensure perfect termination of wires and cables. Terminals of MCBs shall have captive screws.

Basic technical parameters, rating, operating voltage, energy limiting class 3 etc. shall be printed on front face of MCB for ease of identification.

The devices must be capable of heavy-duty operation and to that end, the manufacturer shall guarantee the following performance levels, defined by IEC / EN 60947-2 standards:
- suitability for isolation (section 7.2.7)
- rated insulation voltage (section 4.3.1.2): 500 V
- pollution degree (Part 1, section 6.1.3.2): 3
- rated impulse-withstand voltage (section 4.3.1.3): 6 kV
- Discrimination for power continuity
- Validated Cascading tables as per standard IEC 60947-2

Operating knob shall have provision to lock in ON / OFF condition without affecting any automatic tripping

Circuit-breakers shall be capable of operation under ambient temperature up to 50 °C, without derating of their overload tripping threshold with respect to their rated operating current. The same must be tested and validated as per IEC 60947-2 standard.

The material used to manufacture MCB shall be 100% recyclable and must comply to RoHS and REACH standards.

MCBs shall be suitable for field-fittable Protection auxiliaries (viz. Over-voltage release, Under-voltage release, Shunt trip) and Indication Auxiliaries (like Auxiliary Contact, Trip alarm contact).

The circuit breakers shall be communication ready to indicate the status of the device (On/Off/Trip), Number of On/Off cycles and Number of Tripping over universally open Modbus and Ethernet (TCP IP) protocol so as to have seamless connectivity with any Energy and Building Management System.

In addition the circuit breaker should be able to communicate through GSM module the status of the device (On/Off/Trip) through mobile phone.

1.17 SWITCH BOARD LOCATIONS

1.17.1 General aspects

Switch boards shall be located as indicated on the drawings.

1.18 SWITCH BOARD INSTALLATION:

A switch board shall not be installed so that its bottom is within 1.25 m above the floor.

Where it is required to terminate a number of conduits on a board, it may be convenient to provide a suitable MS adopter box for the purpose. Such boxes shall be provided with the prior approval of the consultants and this will not be paid for separately.

All wires to the boards shall be bushed at the entries to avoid damage to insulation.

No apparatus shall project beyond any edge of the panel.

All unused holes in the boards and in the mountings shall be plugged suitably to avoid entry of insects.

1.19 WIRING OF SWITCH BOARDS AND DISTRIBUTION BOARDS:

All connections between pieces of apparatus, or between apparatus and terminals on a board shall be neatly arranged in a definite sequence, following the arrangement of the apparatus mounted thereon, avoiding unnecessary crossings.

Cables shall be connected to terminals either by crimped or soldered lugs, unless the terminals are of such a form that they can be securely clamped without cutting away of cable strands.

All bare conductors shall be rigidly fixed in such a manner that a clearance of at least 2.5 cm is maintained between conductors of opposite polarity or phase, and between the conductors and any material other than insulating material.

The incoming and outgoing cables shall be neatly bunched and shall be fixed in such a way that the door shall be capable of swinging through an angle of not less than 90 degrees.

1.20 MARKING OF APPARATUS:

(i) Marking of earthed neutral conductor

On the switchgear, the earthed conductor of a two wire system, or an earthed neutral conductor of a multi-wire system, an indication of a permanent nature shall be provided to identify the earthed neutral conductor. In this connection Rule 32(1) of Indian Electricity Rules 1956 (see Appendix C) shall be referred to. The neutral conductor shall be black in colour.

(ii) Main earthing terminal

The main earthing terminal in the main switch board shall be permanently marked as "SAFETY EARTH - DO NOT REMOVE".

All distribution boards shall be marked 'L' for lighting, or 'P' for power, and 'E' for essential as the case may be.

When a board is connected to a voltage higher than 250V, all the terminals or leads of the apparatus mounted on it shall be marked in the following colours to indicate the different poles or phases to which the apparatus or its different terminals may have been connected:

Three phases - Red, Blue & Yellow AND Neutral – Black

Where a four wire, three phase wiring is done, the neutral shall preferably be in one colour, and the other three wires in another colour.

All marking required under this rule shall be clear and permanent.

1.21 ATTACHMENT OF FITTINGS AND ACCESSORIES:

1.21.1 Conduit wiring system

All accessories like switches, socket outlets, call bell pushes and regulators shall be fixed in flush pattern inside the switch/regulator boxes. Accessories like ceiling roses, brackets, batten holders, etc. shall be fixed on metal outlet boxes. The fan regulators shall also be fixed in metal outlet boxes.

Cadmium plated brass screws shall be used to fix the accessories to their bases.

The switch box / regulator box shall be mounted with their bottom 1.25m from floor level, unless otherwise directed by the consultants.

Dash fasteners shall be used for fixing to walls or ceiling.

1.22 FANS REGULATORS AND CLAMPS:

1.22.1 Ceiling fans

Ceiling fans including their suspension shall conform to relevant Indian Standards.

All ceiling fans shall be wired to ceiling roses or to special connector boxes, and suspended from hooks or shackles, with insulators between hooks and suspension rods. There shall be no joint in the suspension rod.

Recessed type fan clamp inside a metallic box as shown in tender drawings shall be used.

Canopies on top of suspension rod shall effectively hide the suspension.
All ceiling fans shall be hung 2.75m above the floor.

In the case of measurement of extra down rod for ceiling fan including wiring, the same shall be measured in units of 10cm. Any length less than 5cm shall be ignored.

The wiring of extra down rod shall be paid as supplying and drawing cable in existing conduit.

1.22.2 Exhaust fans:

Exhaust fans shall conform to relevant Indian Standards.

Exhaust fans shall be erected at the places indicated on the drawings. For fixing an exhaust fan, a circular hole shall be provided in the wall to suit the size of the frame, which shall be fixed by means of rag bolts embedded in the wall. The hole shall be neatly plastered to the original finish of the wall. The exhaust fan shall be connected to the exhaust fan point, which shall be wired as near to the hole as possible, by means of a flexible cord, care being taken to see that the blades rotate in the proper direction.

1.22.3 Regulators:

The metallic body of regulators of ceiling fans/exhaust fans shall be connected to earth by protective conductor.

1.23 WORKMANSHIP:

Good workmanship is an essential requirement to be complied with. The entire work of manufacture/fabrication, assembly and installation shall conform to sound engineering practice.

The work shall be carried out under the direct supervision of a first class licensed foreman, or of a person holding a certificate of competency issued by the State Govt. for the type of work involved, employed by the contractor, who shall rectify then and there the defects pointed out by the consultants during the progress of work.

1.24 COMMISSIONING ON COMPLETION:

Before the workman leaves the work finally, he must make sure that the installation is properly commissioned, after due testing.

1.25 COMPLETION PLAN AND COMPLETION CERTIFICATE:

Completion certificate after completion of work as given in Appendix-`D' shall be submitted to the consultants.

Completion plan drawn to a suitable scale in tracing cloth with ink indicating the following, along with three blue print copies of the same shall also be submitted.

(a) General layout of the building.

(b) Locations of distribution boards, indicating the circuit numbers controlled by them.

(c) Position of all points and their controls.

(d) Types of fittings, viz. fluorescent, pendants, brackets, bulk head, etc. fans and exhaust fans.

1.26 DRAWINGS

The work shall be carried out in accordance with the drawings enclosed with the tender documents and also in accordance with modification thereto from time to time as approved by the consultants.

All circuits shall be indicated and numbered in the wiring diagram and all points shall be given the same number as the circuit to which they are electrically connected.

SECTION – 4

P.V.C. CONDUIT WIRING SYSTEM

1. SCOPE:

This chapter covers the detailed requirements for wiring work in P.V.C. conduits.

1.1 MATERIALS

1.1.1 Conduits

All rigid conduit pipes shall be of P.V.C. and be ISI marked. The wall thickness shall be not less than 2.0 mm for conduits upto 32 mm dia. and not less than 2.5 mm for conduits above 32 mm dia.

The maximum number of PVC insulated cables conforming to IS:694-1990 that can be drawn in one conduit is given size wise in Table I, and the number of cables per conduit shall not be exceeded. Conduit sizes shall be selected accordingly in each run.

No P.V.C. conduit less than 20mm in diameter shall be used.

1.1.2 Conduit accessories

The conduit wiring system shall be complete in all respects, including their accessories.

All conduit accessories shall be of grip type.

Bends, couplers etc. shall be solid type.

All conduit accessories shall be fixed with the help of P.V.C. jointing compound.

1.1.3 Outlets

The switch box or regulator box shall be made of GI on all sides, except on the front. The wall thickness shall not be less than 1.2 mm (18 gauge) for boxes up to a size of 20 cm X 30 cm, and above this size 1.6 mm (16 gauge) thick GI boxes shall be used.

Where a large number of control switches and/or fan regulators are required to be installed at one place, these shall be installed in more than one outlet box adjacent to each other for ease of maintenance.

An earth terminal with stud and 2 metal washers shall be provided in each GI box for termination of protective conductors and for connection to socket outlet/metallic body of fan regulator etc.

Clear depth of the box shall not be less than 51 mm, and this shall be increased suitably to accommodate mounting of fan regulators in flush pattern.

1.2 INSTALLATION:

1.2.1 (i) Conduit joints.

The conduit work of each circuit or section shall be completed before the cables are drawn in.

Conduit pipes shall be joined by means of suitable P.V.C. jointing compound.

Cut ends of conduit pipes shall have no sharp edges, nor any burrs left to avoid damage to the insulation of the conductors while pulling them through such pipes.

The Project Director/Architect, with a view to ensuring that the above provision has been carried out, may require that the separate lengths of conduit etc., after they have been prepared, shall be submitted for inspection before being fixed.

(ii) Bends in conduit

All necessary bends in the system, including diversion, shall be done either by neatly bending the pipes without cracking with a bending radius of not less than 7.5 cm, or alternatively, by inserting suitable solid type normal bends, elbows or similar fittings, or by fixing MS inspection boxes, whichever is most suitable for the particular situation.

No length of conduit shall have more than the equivalent of four quarter bends from outlet to outlet.

(iii) Outlets

All outlets such as switches, wall sockets etc. shall be flush mounting type.

All switches socket outlets and fan regulators shall be fixed on sheet cover of the same manufacturer as that of the accessories.

1.2.2 Additional requirements

(i) Making chase

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

The conduits shall be buried in the wall before plastering, and shall be finished neatly after erection of conduit.

(ii) Fixing conduits in chase

The conduit pipe shall be fixed by means of stapples, J-hooks, or by means of saddles, not more than 60 cm apart.

(iii) Fixing conduits in RCC work

The conduit pipes shall be laid in position and fixed to the steel reinforcement bars by steel binding wires before the concreting is done. The conduit pipes shall be fixed firmly to the steel reinforcement bars to avoid their dislocation during pouring of cement concrete and subsequent tamping of the same.

Fixing of standard bends or elbows shall be avoided as far as practicable, and all curves shall be maintained by bending the conduit pipe itself with a long radius which will permit easy drawing in of conductors.

Location of inspection / junction boxes in RCC work should be identified by suitable means to avoid unnecessary chipping of the RCC slab subsequently to locate these boxes.

(iv) Fixing inspection boxes

Suitable inspection boxes to the minimum requirement shall be provided to permit inspection, and to facilitate replacement of wires, if necessary.

These shall be mounted flush with the wall or ceiling concrete. Minimum 65 mm depth junction boxes shall be used in roof slabs and the depth of the boxes in other places shall be as per IS:2667-1977.

Suitable ventilating holes shall be provided in the inspection box covers.

(v) Fixing switch boxes and accessories

Switch boxes shall be mounted flush with the wall. All outlets such as switches, socket outlets etc. shall be flush mounting type.

(vi) Fish wire

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

(vii) Bunching of cables

Cables shall always be bunched so that the outgoing and return cables are drawn into the same conduit.

Where the distribution is for three phase loads only, conductors for all the three phases and neutral wire shall be drawn in one conduit.

1.3 Earthing requirements

The entire system of metallic conduit work, including the outlet boxes and other metallic accessories, shall be mechanically and electrically continuous by

proper joints. The conduit shall be continuous when passing through walls or floors.

Protective (loop earthing) conductor(s) shall be laid along the runs of the conduit between the metallic switch boxes and the distribution boards/ switch boards, terminated thereto. These conductors shall be of such size and material as specified. Depending upon their size and material, the protective earth conductors shall be either drawn inside the conduits along with the cables, or shall be laid external to the conduits. When laid external to the conduits, this shall be properly clamped with the conduit at regular intervals.

The protective conductors shall be terminated properly using earth studs/ earth terminal block etc. as required.

Gas or water pipe shall not be used as protective conductor (earth medium).

TABLE I

Maximum number of PVC insulated 650/1100 V grade copper conductor cable conforming to IS:694-1990 which can be drawn through a conduit

Nominal cross-sectional area of conductor in sq. mm.	20 mm		25 mm		32 mm		38 mm		51 mm	
	S	B	S	B	S	B	S	B	B
1	2	3	4	5	6	7	8	9	11
1.50	5	4	8	7	16	10	-	-	-	-
2.50	4	3	7	5	10	8	-	-	-	-
4	3	2	6	5	9	7	-	-	-	-
6	2	-	5	4	8	6	-	-	-	-
10	2	-	3	2	5	4	7	6	-	-
16	-	-	2	2	3	3	6	5	10	7
25	-	-	-	-	3	2	5	3	8	6
35	-	-	-	-	-	-	3	2	6	5

Note :

The above table shows the maximum capacity of conduits for a simultaneous drawing in of cables.

The columns headed 'S' apply to runs of conduits which have distance not exceeding 4.25 m between draw in boxes and which do not deflect from the straight by an angle of more than 15 degrees. The columns headed 'B' apply to runs of conduit which deflect from the straight by an angle of more than 15 degrees.
Conduit sizes are the nominal external diameters.

SECTION – 5

METALLIC CONDUIT WIRING

1. SCOPE:

This chapter covers the detailed requirements for wiring work in metallic conduits.

1.1 MATERIALS

1.1.1 Conduits

All rigid conduit pipes shall be of steel and be ISI marked. The wall thickness shall be not less than 1.6 mm (16 SWG) for conduits upto 32 mm dia. and not less than 2 mm (14 SWG) for conduits above 32 mm dia. These shall be solid drawn or reamed by welding, and finished with stove enamelled surface.

The maximum number of PVC insulated cables conforming to IS: 694-1990 that can be drawn in one conduit is given sizewise in Table I, and the number of cables per conduit shall not be exceeded. Conduit sizes shall be selected accordingly in each run.

No steel conduit less than 20mm in diameter shall be used.

1.1.2 Conduit accessories

The conduit wiring system shall be complete in all respects, including their accessories.

All conduit accessories shall be of threaded type, and under no circumstances pin grip type or clamp grip type accessories shall be used.

Bends, couplers etc. shall be solid type.

1.1.3 Outlets

The switch box or regulator box shall be made of sheet metal on all sides, except on the front. The wall thickness shall not be less than 1.2 mm (18 gauge) for boxes upto a size of 20 cm X 30 cm, and above this size 1.6 mm (16 gauge) thick MS boxes shall be used. The metallic boxes shall be duly painted with anticorrosive paint before erection as per chapter 10 of these Specifications.

Where a large number of control switches and/or fan regulators are required to be installed at one place, these shall be installed in more than one outlet box adjacent to each other for ease of maintenance.

An earth terminal with stud and 2 metal washers shall be provided in each MS box for termination of protective conductors and for connection to socket outlet/metallic body of fan regulator etc.

Clear depth of the box shall not be less than 60 mm, and this shall be increased suitably to accommodate mounting of fan regulators in flush pattern.

1.2 INSTALLATION:

(i) Conduit joints.

The conduit work of each circuit or section shall be completed before the cables are drawn in.

Conduit pipes shall be joined by means of screwed couplers and screwed accessories only. Threads on conduit pipes in all cases shall be between 13 mm to 19 mm long, sufficient to accommodate pipes to full threaded portion of couplers or accessories.

Cut ends of conduit pipes shall have no sharp edges, nor any burrs left to avoid damage to the insulation of the conductors while pulling them through such pipes.

The consultants, with a view to ensuring that the above provision has been carried out, may require that the separate lengths of conduit etc., after they have been prepared, shall be submitted for inspection before being fixed.

No bare threaded portion of conduit pipe shall be allowed, unless such bare threaded portion is treated with anticorrosive preservative or covered with approved plastic compound.

(ii) Bends in conduit

All necessary bends in the system, including diversion, shall be done either by neatly bending the pipes without cracking with a bending radius of not less than 7.5 cm, or alternatively, by inserting suitable solid type normal bends, elbows or similar fittings, or by fixing MS inspection boxes, whichever is most suitable for the perticular situation.

No length of conduit shall have more than the equivalent of four quarter bends from outlet to outlet.

(iii) Outlets

All outlets such as switches, wall sockets etc. shall be flush mounting type.

All switches socket outlets and fan regulators shall be fixed on sheet cover of the same manufacturer as that of the accessories.

(iv) Painting after erection

After installation, all accessible surfaces of conduit pipes, fittings, switch and regulator boxes etc. shall be painted in compliance with the clauses under Chapter 6 - `Painting'.

1.3 Additional requirements

(i) Making chase

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

The conduits shall be buried in the wall before plastering, and shall be finished neatly after erection of conduit.

Fixing conduits in chase

The conduit pipe shall be fixed by means of stapples, J-hooks, or by means of saddles, not more than 60 cm apart.

All threaded joints of conduit pipes shall be treated with approved preservative compound to secure protection against rust.

(ii) Fixing conduits in RCC work

The conduit pipes shall be laid in position and fixed to the steel reinforcement bars by steel binding wires before the concreting is done. The conduit pipes shall be fixed firmly to the steel reinforcement bars to avoid their dislocation during pouring of cement concrete and subsequent tamping of the same.

Fixing of standard bends or elbows shall be avoided as far as practicable, and all curves shall be maintained by bending the conduit pipe itself with a long radius which will permit easy drawing in of conductors.

Location of inspection / junction boxes in RCC work should be identified by suitable means to avoid unnecessary chipping of the RCC slab subsequently to locate these boxes.

(iii) Fixing inspection boxes

Suitable inspection boxes to the minimum requirement shall be provided to permit inspection, and to facilitate replacement of wires, if necessary.

These shall be mounted flush with the wall or ceiling concrete. Minimum 65 mm depth junction boxes shall be used in roof slabs and the depth of the boxes in other places shall be as per IS:2667-1977.

Suitable ventilating holes shall be provided in the inspection box covers.

(iv) Fixing switch boxes and accessories

Switch boxes shall be mounted flush with the wall. All outlets such as switches, socket outlets etc. shall be flush mounting type.

(v) Fish wire

To facilitate subsequent drawing of wires in the conduit, GI fish wire of 1.2 mm (18 SWG) shall be provided alongwith the laying of the recessed conduit.

(vi) Bunching of cables

Cables shall always be bunched so that the outgoing and return cables are drawn into the same conduit.

Where the distribution is for three phase loads only, conductors for all the three phases and neutral wire shall be drawn in one conduit.

1.4 Earthing requirements

The entire system of metallic conduit work, including the outlet boxes and other metallic accessories, shall be mechanically and electrically continuous by proper screwed joints, or by double checknuts at terminations. The conduit shall be continuous when passing through walls or floors.

Protective (loop earthing) conductor(s) shall be laid along the runs of the conduit between the metallic switch boxes and the distribution boards/ switch boards, terminated thereto. These conductors shall be of such size and material as specified. Depending upon their size and material, the protective earth conductors shall be either drawn inside the conduits alongwith the cables, or shall be laid external to the conduits. When laid external to the conduits, this shall be properly clamped with the conduit at regular intervals.

The protective conductors shall be terminated properly using earth studs/ earth terminal block etc. as required.

Gas or water pipe shall not be used as protective conductor (earth medium).

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TABLE I

Maximum number of PVC insulated 650/1100 V grade copper conductor cable conforming to IS:694-1990 which can be drawn through a conduit

Nominal cross-sectional area of conductor in sq. mm.	20 mm		25 mm		32 mm		38 mm		51 mm		64 mm	
	S	B	S	B	S	B	S	B	S	B	S	B
1	2	3	4	5	6	7	8	9	10	11	12	13
1.50	5	4	10	8	18	12	-	-	-	-	-	-
2.50	5	3	8	6	12	10	-	-	-	-	-	-
4	3	2	6	5	10	8	-	-	-	-	-	-
6	2	-	5	4	8	7	-	-	-	-	-	-
10	2	-	4	3	6	5	8	6	-	-	-	-
16	-	-	2	2	3	3	6	5	10	7	12	8
25	-	-	-	-	3	2	5	3	8	6	9	7
35	-	-	-	-	-	-	3	2	6	5	8	6

Note:
The above table shows the maximum capacity of conduits for a simultaneous drawing in of cables.

The columns headed 'S' apply to runs of conduits which have distance not exceeding 4.25 m between draw in boxes and which do not deflect from the straight by an angle of more than 15 degrees. The columns headed 'B' apply to runs of conduit which deflect from the straight by an angle of more than 15 degrees.

Conduit sizes are the nominal external diameters.

****

SECTION – 6

PAINTING

1.0 SCOPE

This chapter covers the requirements of painting work in internal electrical installations, carried out manually by brush. This does not cover spray painting work of factory made items.

1.1 PAINTING WORK IN GENERAL

1.1.1 Paints

Paints, oils, varnishes etc. of approved make in original tin to the satisfaction of the consultants shall only be used.

1.1.2 Preparation of the surface

The surface shall be thoroughly cleaned and made free from dust or foreign matter before painting is started. The proposed surface may be inspected by the consultants before the paint is applied.

1.1.3 Application

Paint shall be applied with brush. The paint shall be spread as smooth and even as possible. Particular care shall be paid to rivets, nuts, bolts and over-lapping. Before drawing out in smaller containers, it shall be continuously stirred with a smooth stick, while painting work is taken up.

Primer coat of anti-corrosive paint shall be given in the case of steel work, after preparing the surface. In all cases of painting work, finishing shall be with 2 coats of paint in approved shade.

Each coat shall be allowed to dry out sufficiently before a subsequent coat is applied.

1.1.4 Precautions

All furniture, fixtures, glazing, floors etc. shall be protected by suitable covering. All stains, smears, splashings, dropping etc. shall be removed. While painting of conduits etc. it shall be ensured that the painting of wall and ceiling etc. is not spoiled in any way.

1.2 PAINTING OF CONDUITS AND ACCESSORIES

Requirement of painting of metallic conduits before installation on surface shall be met as per clause 3.3.(iv)

SECTION – 7

LIGHTING FIXTURES

All lighting fixtures shall be suitable for use on single Phase, 230 Volts, and 50 cycles AC supply system.

Fixtures shall be provided with heavy duty low loss open construction copper wound ballast, power factor improvement capacitor, lamp and starter holders and connector block. The control gear shall be rugged in construction and shall function without overheating over the entire length of its useful life. The starter shall be suitable for repeated switching operations without premature failure.

All fixtures shall be duly wired with appropriate size of copper conductor, PVC insulated wire. All wires, when passing near a heat source within the fixture, shall be provided with an additional protective sleeve.

Suitable earthing terminal shall be provided.

The Fixture body made of Aluminium/ CRCA MS shall be duly precision fabricated, duly finished, pretreated and powder coated / Stove enameled. The body shall be so designed to ensure sufficient heat dissipation and avoid overheating of control gear.

All hardware shall be MS zinc Passivated and shall resist rusting. Locking nuts/ washers shall be provided wherever required to prevent accidental loosening.

All aluminium reflectors wherever provided shall be electrochemically brightened and anodized.
The optical system shall be designed for optimum light distribution.

The fixtures shall be complete with all accessories and shall be ready for use.

SECTION – 8

ELECTROLYTIC MAINTENANCE FREE EARTHING

The effective earthing connection surface should be smooth & free from paints and oxide coatings

MAINTENANCE FREE EARTHING

A. GENERAL

1. Self-contained ground electrode(s) using electrolytically enhanced grounding where specifically indicated on the drawings.

2. The electrode shall operate by hygroscopic ally extracting moisture from the atmosphere to activate the electrolytic process.

3. Electrode shall be 100% self-activating, sealed and maintenance free. No additions of chemical or water solutions required.

4. To achieve specific earth resistance, contact manufacturer for engineering and applications support.

B. TECHNICAL SPECIFICATIONS

Types & Technical Specifications (Long Life Maintenance Free Earthing Solution)

System Model / Type	Soil	Warranty (years)	Current Cap-acity	Electrode Details			TF Qty	Test Well Cover
				Length **(feet)**	Outer Dia. **(inch)**	Thick-ness **(mm)**	(Bags)	
C-TEG-10S/ TRIPODE-Cu-50-3	Non Rocky	30	1kA/9Sec	10	2	2	3	Poly-plastic

1. The specifications with performance warranty and technical spec details shown in the tables.

2. The ground rod shall be filled from the factory with non-hazardous metallic salts to form the electrolytic process and enhance the grounding performance.

3. Ground rod shall be a minimum of ten feet long. TerraDyne® Model # TG-10S or TRIPODE **–**Cu-50-3 may be used.

OR

Selection of models depends on the user choice.

4. A Solid Tinned AWG Cu ground cable shall be exothermically welded to the side of the rod for conductor connection OR 40x5mm OR 50x5mm OR 100x150x6mm used for conductor connection.

5. For Rocky or excavation condition are poor Model # TerraDyne TG-10L may be used with same Dia and Thickness. Only the difference in this model is **L shaped with 36"** vertical riser (shape) and rest in horizontal shape.

OR

6. The Crowfoot Bar earthing systems used for is one of the best alternate of Maintenance Free Earthing in the Rocky area.

7. A Solid Tinned AWG Cu ground cable/50x5mm copper plate shall be exothermically welded to the side of the rod for conductor connection

C. Protective Test Well

1. Polyplastic well for non-traffic applications. Includes bolt down flush cover with
"breather ports." TerraDyne® Model #910

–OR**–**

2. Fiberlyte well for traffic and industrial applications. Wheel loading 4.5 Tons. TerraDyne® Model #FL8-TB

D. Environment Friendly Backfill Material

1. Non-corrosive, electrically conductive and ground enhancing backfill. TerraFill® Model # TF-50. TerraFill /TRIPODE FILL will lower the contact resistance to earth by up to 63 % when used in conjunction with copper grounding equipment.

E. Excavation

1. Bore a hole into the earth (minimum diameter 6"). Hole should be bored to allow installed unit to be as close to vertical as possible

2. A 14" hole must be provided for the cover box.

3. Depth of hole must be 6" deeper than the vertical length of the system.

4. Top vent ports must be left open to the atmosphere for continuous air circulation by using the protective test well provided.

5. Plate Type Earthing (Cu/GI), Crow Foot Earthing and Cu Claded rod earthing, the mixing procedure of Backfill will be same as like in the electrolytic Earthing.

F. Installation

1. Remove sealing tapes from the bottom of unit only. Tapes must be saved and made
   available to the electrical inspector to verify removal and proper installation. Do NOT **remove the green and white "Bury** to **Here" marker from the top** of the unit.

2. Position the unit in **the hole. Use green and white "Bury** to **Here" marker a**s a guide to depth in which unit shall be buried in TerraFill®. Three bags of TerraFill® are included with each 10' electrode.

3. Pour TerraFill® around electrode in augured hole. Do not mound backfill past green and white marker.

4. Place box with cover over the top of the electrode so that the cover is at grade level. Use backfill to stabilize box around the electrode. This keeps the breather holes free of obstruction and debris. Top of box should not contact the top of the electrode.

5. Remove top sealing tape ONLY after backfill is complete. This prevents soil from blocking the vent ports.

   Above installation must be taken place in presence of UL listed company.

G. Connection

1. Connect grounding conductor to ground rod pigtail exothermally.

2. Bury grounding conductor 30inch below grade

SECTION – 9

EARTHING:-

1. SCOPE:

This chapter covers the essential requirements of earthing system components and their installation. For details not covered in these Specifications, IS Code of Practice on Earthing (IS: 3043-1987 ammended upto date) shall be referred to.

2. APPLICATION

The electrical distribution system in the campus is with earthed neutral (i.e., neutral earthed at the transformer/ generator end). In addition to the neutral earthing, provision is made for earthing the metallic body of equipments and non-current carrying metallic components in the sub-station, as well as in the internal electrical installations.

Earthing requirements are laid down in from time to time, and in the Regulations concerned.	Indian Electricity Rules, 1956, as amended of the Electricity Supply Authority

3. MATERIALS

3.1 EARTH ELECTRODES

3.1.1 Types

The type of earth electrode shall be Chemical earth electrode.

3.2.1 Electrode materials and dimensions

The materials and minimum sizes of earth electrodes shall be as per BOQ.

3.2.2 EARTHING CONDUCTOR:

The earthing conductor (protective conductor from earth electrode up to the main earthing terminal/earth bus, as the case may be) shall be of the same material as the electrode, viz. GI or copper, and in the form of wire or strip as specified in BOQ.

3.2.4 HARDWARE ITEMS

All hardware items used for connecting the earthing conductor with the electrode shall be of GI in the case of GI pipe and GI plate earth electrodes, and forged tinned brass in case of copper plate electrodes.

3.2.5 PROTECTIVE (Earth continuity/Loop earthing) CONDUCTOR:

The material and size of protective conductors shall be as specified in the BOQ.

4 LOCATION FOR EARTH ELECTRODES

Normally an earth electrode shall not be located closer than 1.5 m from any building. Care shall be taken to see that the excavation for earth electrode does not affect the foundation of the building; in such cases, electrodes may be located further away from the building, with the prior approval of the consultants.

The location of the earth electrode will be such that the soil has a reasonable chance of remaining moist as far as possible. Entrances, pavements and road ways, should be avoided for locating earth electrodes.

5 INSTALLATION 5.1 ELECTRODES

5.1.1 Various types of electrodes

Plate electrode shall be buried in ground with its faces vertical, and its top not less than 3 m below the ground level.

When more than one electrode (plate/pipe) is to be installed, a separation of not less than 2 m shall be maintained between two adjacent electrodes.

5.2 Artificial treatment of soil

The electrode shall be surrounded by Chemical compound as indicated in tender drawings

6. EARTHING CONDUCTOR (Main earthing lead)

In the case of plate earth electrode, the earthing conductor shall be securely terminated on to the plate with two bolts, nuts, check nuts and washers.

The earthing conductor from the electrode up to the building shall be protected from mechanical injury by a medium class by 40 mm dia. medium class GI pipe in the case of strip. The protection pipe in ground shall be buried at least 30 cm deep (to be increased to 60 cm in case of road crossing and pavements). The portion within the building shall be recessed in walls and floors to adequate depth in due co-ordination with the building work.

The earthing conductor shall be securely connected at the other end to the earth stud/earth bar provided on the switch board by bolt, nut and washer.

7. PROTECTIVE (Loop earthing/earth continuity) CONDUCTOR

Earth terminal of every switch board in the distribution system shall be bonded to the earth bar/terminal of the upstream switch board by protective conductor(s).

Two protective conductors shall be provided for a switch board carrying a 3 phase switchgear thereon.

The earth connector in every distribution board (DB) shall be securely connected to the earth stud/earth bar of the corresponding switch board by a protective conductor.

All metallic switch boxes and regulator boxes in a circuit shall be connected to the earth connector in the DB by protective conductor (also called circuit protective or loop earthing conductor), looping from one box to another upto the DB.

The earth pin of socket outlets as well as metallic body of fan regulators shall be connected to the earth stud in switch boxes by protective conductor. Twisted earth connections shall not be accepted in any case.

8. EARTH RESISTANCE

The earth resistance at each electrode shall be measured. No earth electrode shall have a greater ohmic resistance than 5 ohms as measured by an approved earth testing apparatus.

Where the above stated earth resistance is not achieved, necessary improvement shall be made by additional provisions, such as additional electrode(s), different type of electrode, or artificial chemical treatment of soil etc., as may be directed by the consultants.

9. MARKING:

Earth bars/terminals at all switch boards shall be marked permanently, "E" or as;

Main earthing terminal shall be marked "SAFETY EARTH - DO NOT DISCONNECT".

TABLE VIII

MATERIALS AND SIZES OF EARTH ELECTRODES

Type of Electrode	Material	Size
Plate	Copper	60 cm x 60 cm x 3 mm thick
Plate	GI	60 cm x 60 cm x 6 mm thick

It shall be carried out as per C.P.W.D GENERAL SPECIFICATIONS FOR ELECTRICAL WORKS (PART-I INTERNAL) - 2007 with all upto date amendments.

SECTION – 10

MAIN L.T. PANEL AND FLOOR PANELS

1.0 L.T. PANEL

The non-draw out type L.T. Panel shall be with aluminum bus bars, indoor type, free standing, floor mounting type, extensible on either side.

2.0 SITE CONDITIONS:

Max. peak room temperature in shade: 45°C.
Altitude - 200 mtrs. above mean sea level.

3.0 STANDARDS:

The design, manufacture & testing of the various items are covered by the following standards:

IS 8623 - 1993	:	Low Voltage switchgear & control gear assemblies.
IS13947(P1)-1993	:	General requirement for Switchgear and Control gear for voltages not exceeding 1000V.
IS12729 -1988	:	General requirement for Switchgear and Controlgear for voltages exceeding 1000V.
IS13947(P1)-1993	:	Degree of protection provided by enclosure for low voltage switchgear and Control gear.
IS 3619 - 1966) IS 6005 - 1970)	:	Phosphate treatment.
IS 5 - 1978	:	Colour for ready mixed paints & enamels.
IS 5082 - 1969	:	Wrought aluminum for electrical purpose.
BS - 162	:	Clearance & creepage for bus systems.
IS 5578	:	Marking arrangement for busbar/ cable.
IS 13947 Part-1	:	Clearances & Creepages for devices.

IS 13945 (Part-1, Sec.-1)	:	Push buttons & related control switches including control contactors.
IS 13703 Part I &	:	HRC Fuses.
IS13947 (P-2)-1993	:	LV switchgear & control gear circuit breakers.
IS 3231 - 1965	:	Protective relays.
IS 3156 - 1992	:	Voltage transformers.
IS 2705 - 1992	:	Current transformers.
IS 1248 - 1968	:	Elect. indicating instruments.
IS 8878 - 1993	:	Miniature Circuit Breakers.
IS 10118(P3) –1982	:	Code of Practice for Installation of Switchgear.

4.0 SPECIFICATIONS:

Rated System	:	415V. 50Hz. TPN.
Rated insulation level	:	1100V rms.
HV withstand level (for 1 min).	: :	2.5 KV rms for power circuit. 1.5 or 2.0KV rms for control circuit
Horizontal busbar rating.	:	As indicated in B.O.Q. / Drawings.
Rated short time rating of H.Bus & V.Bus.	:	Upto 50kA rms for 1 sec. 110kA peak (36MVA).
Protection of enclosure.	:	IP54.

5.0 CONSTRUCTION:

The standard L.T. Panel shall contain a basic frame assembly reinforced with formed sheet steel profiles and cross members. Sheet steel partitions shall be bolted to this frame to form the full structure. Basic structure is made out of minimum 2 mm. thick sheet steel. The load bearing members are made out of 2mm thick and non-load member items are out of 1.6 mm. thick sheet steel. All sheet steel shall be cold rolled.

The pretreatment process shall involve de-greasing, rinsing, de-scaling, rinsing, de-rusting, rinsing, phosphating, rinsing & passivation. After this, it shall be spray finished with a primer, oven dried and spray painted with a finish paint, 2 coats wet on wet. Then it shall be baked in oven to achieve an uniform, smooth and tough film. The standard shade offered shall be light gray shade 631 semigloss as per IS:5. The painting shall be with synthetic enamel stoving grade to a final overall dry film thickness of 30/40 microns.

The Panel design shall be of single front cubicle, compartmentalized with horizontal busbars mounted at top, extensible on either side. The breaker, instruments and aux. equipments shall be accessible from front. The cable terminations shall be accessible from the rear side.

Each section shall be divided into 3 compartments, enclosing either Air Circuit Breakers or On Load Change Over Switch fuse Units or Switch Fuse/Fuse Switch Units or Auxiliary equipments. Max. of 2 tier ACB compartments shall be provided in one section.

A standard transportable shipping section shall contain max. three sections with length not exceeding 3 m and weight not exceeding 2.5 tonnes.

The standard draw out ACB shall have two parts namely:

i) Draw out carriage with 4P incoming & outgoing power terminals & Controls sliding contacts.

ii) Basic breaker with mechanism & releases mounted on sliding rails.

The sliding contacts shall be provided for control circuit.

When the ACB is in test position, the power circuit shall be disconnected and control circuits shall be engaged through sliding contacts.

This test position shall permit a ready inspection of all the mechanism, interlocks, automatic devices and electrical indicators.

Automatic safety shutters shall be provided for personal safety against accidental live contact to terminal when the breaker is fully drawn out.

The incoming terminals of the breakers shall be connected to the busbar by suitable links. The outgoing terminals shall be extended in the cable chamber for direct Bus Truncking/ cable connections. These shall be identified by coloured PVC tape/paint, wherever required link extension to form busduct entry from top shall also be provided. Adequate shrouding and caution notice plate shall be provided to prevent the accidental contact to live terminals.

The ACBs shall be mounted on the channel frame and shall be partitioned at the top by insulated barrier on the either side by sheet metal barrier with necessary cutout for power

linking for control wiring. The control equipment, fuses, timers, contractors, etc., shall be laid out in standard fashion on a painted base plate and fixed with screws to the frame at appropriate location.

Each ACB module compartment shall be provided with front access door made out of 2 mm. thick sheet steel.

Basic instrument such as ammeter, voltmeter/Multi function meter with selector switch and lamps shall be provided on the ACB module door itself. Meters such as KW, Hz, PF may be provided in a separate module for a single tier ACB or on the vertical bus door for a 2 tier ACB panel. KWh meters or KVA meter with or without MDI and protective relays shall be located in the bottom most compartment or on the vertical bus chambers. Meters/relays shall be identified with feeder identification name plates when they are located away from feeder module.

Suitable inscription plates shall be provided to identify the feeders, function of the doors mounted devices and caution plate shall be provided at appropriate locations.

Cubicle illuminating lamp, 240V, 5A, 3 pin plug and socket shall be provided with MCB for protection in cable chamber a standard item in each compartment.

Suitable M.S. removable, undrilled gland plates shall be provided. For single core cables non magnetic gland plates shall be provided.

6.0 SAFETY INTERLOCKS

The following safety interlock shall be provided for each module:

i) When ACB is ON door cannot be opened - electrically or mechanically. (Defeat interlock to be provided.)

ii) Padlocking in OFF position (locks to be provided.)

iii) Castell interlocks for feeder co-ordination as per B.O.Q./ Drawings.

7.0 AIR CIRUIT BREAKERS:

The Air Circuit Breaker shall be of modular type construction, 3P,4P, draw out or non-draw out type with single frame size upto 4000A and other detail as indicated in the Schedule of Quantities. Rated impulse withstand voltage shall be 12kv and operational voltage should be 690V.

The air circuit breakers shall comply with IS - 13118 **–** 1991 & IS - 2516 **–** 1977/IEC-60947-1&2.

The air circuit breakers shall have 100% certified rating when mounted in the panel and there should not be any de-rating up to 50 degree. (All de-rating factors shall be clearly indicated by the contractor in his offer). Ics=Icu=Icw=35KA for 1sec. ACB shall be provided with Fully rated Neutral with protection against O/L & S/C with settings at 50%-100%- OFF.

The air circuit breakers shall be (as indicated in the schedule of quantities) either manually operated or with motor operated store charged, spring closing mechanism in which case the motor shall be suitable for 230V AC supply. The motorized mechanism shall charge a closing spring upon circuit connection. This charged spring may be electrically or manually released effecting the closer of the breaker. The closing spring shall automatically be recharged for the next closing command. An Operator shall also be in position to manually charge the closing spring. The spring condition `Charged' or `Free' shall be visible through the indicator. ACB shall have Flexibility in terminal orientation by 90 degree.

All EDO ACB shall be provided with "Ready to close contact". ACB accessories should be

common for entire range and should be continuously rated. ACB shall be provided with **inbuilt "Thermal Memory" before & after tripping.**

Fault lock out/anti-pumping device shall be provided on each breaker so that it could not be re-closed after tripping on fault without manual resetting being done.

The incoming and the outgoing breakers shall be provided with Microprocessor based release. These release/relays should have the following adjustments:

a) Over current pick-up.

b) Inverse tripping time at 6 times the current setting.

c) Short time delay pick-up at various current settings.

d) Short time delay - instantaneous.

e) Earth fault pick-up at various current settings.

f) Earth fault delay - instantaneous.

Release should have LCD Display for current parameters with a combined accuracy of less than 2% as per IEC61557-12. Release setting should be thru DIAL type potentiometers as well as thru Navigation Keys. Release shall be provided with LED indication for "Fault Differentiation" and the release shall be self powered type.

The incoming and the outgoing breakers shall be provided either with static trip release integrally mounted on the breakers/or other suitable relays. This release/relays shall be as per B.O.Q. item.

The breakers being used as bus couplers shall be without integral release. An AC shunt trip release shall be provided with under-voltage release back-up to operate these bus coupler breakers.

The air circuit breaker being used as incomer buscoupler & outgoings shall have the accessories, indications, meters, provided on its housing as per B.O.Q. item

NOTE: All ACB.s to be used inis project shall be computer compatible.

COMBINATION FUSE SWITCH DISCONNECTORS and ON LOAD CHANGE OVER SWITCH FUSE UNITS:

These Units should comply with IS:13947-(Series) 1993 amended upto date. These should be suitable to accommodate high rupturing capacity cartridge fuse-links complying with IS:13703(Series) amended upto date and having a certified rupturing capacity of not less than 50KA, at 415Volts. These shall be of four pole type.

8.0 CONSTRUCTION:

The unit housing shall be of robust construction designed to withstand the hardest conditions met in industry. It should have double breaks per phase to ensure complete isolation of the fuse links when the unit is in the `off' (isolation) position. The `on' and `off' positions of the handle shall be clearly indicated and the action of the switch should be positive. The contacts of all units should be silver-plated.

Interlocks must be provided to ensure that the enclosure cannot be opened until the switch is in the `off' position. It should, however, be possible for a competent examiner to operate the switch with the enclosure open by releasing a suitable interlock.

The switch should have an external earthing terminal to enable the enclosure to be earthed. The arrangement and disposition of the parts in the unit should provide for straight through connections thereby avoiding looping in of cables. The unit should be fitted with top and bottom detachable end cover and provision should be made for fixing cable boxes to the flanges of the unit in place of end covers.

The unit should be capable of breaking the stalled current of the largest induction motor with which it is likely to be associated. If necessary, the contractor should be prepared to produce type test certificates set out in the appropriate Indian standards with which the unit complies.

It shall also have the following indications and metering;

a) CT operated ammeter of suitable rating complete with CT and selector switch.

b) 1 No. indicating lamps for the followings
   i) Red for SFU/COSFU ON

9.0 MOULDED CASE CIRCUIT BREAKERS:

The normal Moulded case circuit breakers shall be as per IEC-60947-2 and shall have all live parts totally enclosed in a moulded insulated housing i.e. should be suitable for Class-

II front face as per IEC 60441. It shall have a quick make and quick break mechanism. MCCBs must be **suitable for "Positive Isolation" as per IEC 60947**-2. The mechanism shall be trip free so that the contacts cannot be held closed against a fault. The bi-metallic mechanism shall be provided for inverse time current trip characteristic, to prevent interruption on normal inrush currents or temporary overloads. The instantaneous release shall be provided to protect equipment against very high current or short circuits. There shall be a common trip bar so that in case of fault on any of the phases, all the three phases trip together.

Ics=100% Icu for complete range.

MCCB rated upto 250 A shall have Thermal Magnetic release (Variable O/L & Fixed S/C) and MCCB > 250 A should have Microprocessor based release with variable O/L & S/C settings. Modular Ground Fault Protection shall be provided as & when required. It should not be possible to switch off / By pass the E/F Protection. Add on E/F Module shall have LED indication for fault differentiation. MCCB shall have Cross Bolted Termination to withstand higher short Ckt Levels

The arcing shall be totally contained within the housing so that the possibility of any damage to any adjacent equipment or personnel due to accidental mishandling is avoided. Individual arc chutes shall be provided on each phase to draw the arc away from the contact tips, thus, quenching it rapidly.

The minimum breaking capacity of Moulded Case Circuit Breakers shall be as per SLD /BOQ. Each Moulded Case Circuit Breakers shall have the following accessories;

a) Auxiliary switch.
b) Remote trip facility.

Accessories should be common & snap fit type and shall be continuously rated (shunt trip). It shall also have the following indications and metering;

a) CT operated ammeter of suitable rating as indicated on the drawing/s complete with CT and selector switch.

b) 1 Nos. indicating lamps for the followings
   i) Red for MCCB ON

c) 3 Nos. phase indicating lamps

10.0 BUSBAR SYSTEM:

10.1 HORIZONTAL BUSBAR:

The horizontal busbars shall be located at the top/ bottom/ center busbar compartment. The busbars shall be of electrical grade, high conductivity, Aluminium sections of required ratings.

10.2 VERTICAL BUSBAR:

The vertical busbar shall also be made from high conductivity electrical grade aluminium sections, the rating and size shall depend upon the total rating of all feeders in the column considering the diversity factors O.9. The busbars shall be provided with black heat shrinkable PVC sleeving/PVC taping with R.Y.B phase identification at regular intervals.

10.3 NEUTRAL BUS:

It shall run parallel to horizontal and vertical busbars. Standard neutral busbar size is half the size of main busbar.

10.4 CONTROL BUSBAR:

Control bus of 60A and 415V shall be provided at top in the front portion. These shall be supported with insulator at required interval.

10.5 EARTH BUS:

50 x 6 mm. copper earth bus shall be provided in the bottom most compartment along the entire length of the board for connection to project earth at either end.

10.6 BUS JOINTS:

Joining between bus bars shall be by using rigid or flexible bus links.

10.7 BUS BAR SUPPORTS :

Both horizontal and vertical bus bars shall be supported at uniform intervals on high impact, anti-tracking, non-hygroscopic, arc resistant, flame retardant, self extinguishing GRP (Glass reinforced plastics), insulators. These insulators shall be type tested for short circuit withstand capacity.

11.0 MODULES:

11.1 INCOMER:

ACB in single tier shall be provided as incomer from transformer. Cable entry from top shall be provided for each incomer breaker.

11.2 OUTGOING FEEDERS:

The outgoing feeders shall be as indicated in B.O.Q./ Drawing. Irrespective of the panel depths, the panels shall be coupled front flush. Each outgoing feeder shall have the provision for Cable/bus duct connection from the bottom/top.

12.0 CONTROL WIRING:

All control wiring shall be done as a standard, using 1.5 sq.mm. multistrand pvc insulated copper wires. These shall be black in color for AC and grey in color for DC. The C.T. connections shall be done using 2.5 sq.mm. multistrand PVC insulated copper wires of red color.

The outgoing control wires shall be terminated from the equipment terminals to control terminal block in cable chamber. Whenever required PVC channels shall be used for wire routing. On either ends of these wires self locking yellow ferrules with black letters shall be provided. Multistrand wire termination shall be provided with crimping type lugs.

13.0 INTER-MODULE WIRING:

The control wiring between modules located in the same vertical section shall be connected at the respective terminal blocks/terminals. These shall be routed through the cable duct in PVC wire channels. Inter connections between adjacent cubicle in the same shipping sections shall be done in a similar way.

14.0 CURRENT TRANSORMERS:

Current transformer meant for metering & protection shall be mounted on the bus links either on the incoming side or outgoing side as the case may be. They shall be wired and terminated suitably for external connection.

15.0 FUSES

All fuses shall be of the HRC cartridge type, conforming to IS:13703 mounted on plug-in type of fuse bases having a prospective current rating of not less than 50 KA. Fuses shall be provided with visible operation indicators to show that they have operated. Insulated fuse pulling handle shall be supplied with each control panel.

16.0 INDICATING INSTRUMENTS & METERS

Electrical indicating instruments shall be flush mounted digital type having min. 96 mm square dial.

17.0 CONTROL AND SELECTOR SWITCHES

Control and instrument switches shall be of the rotary type and shall be provided with properly designated plate. Control switches shall have momentary contacts spring return to center with pistol grip handle. Instrument and selector switches shall have stay put contacts.

18.0 PUSH BUTTONS

All push buttons shall be of push to actuate type having 2 `NO' and 2 `NC' self reset contacts. They shall be provided with designation plates, engraved with their functions. push button contacts shall be rated for 10 amps at 415V A.C. and 0.6 Amp. inductive breaking at 220V D.C.

19.0 INDICATING LAMPS

Indicating lamps shall be of the filament type having double contact bayonet caps and low watt consumption. Lamps shall preferably be provided with series resistors to prevent short circuiting of control supply of filament fusing. Colour of lens shall be as per enclosed drawing/data sheet. Lamp grip shall be supplied along with the panel so that replacement of the bulb can easily be done from the front of the panel.

The panel boards having power factor correction relay as one of the components, shall have enough space to house the power factor correction capacitors Owners also in the panel itself.

20.0 DRAWINGS

The contractor shall provide the following drawings for approval to Consultants/Engineer in Charge before commencement of supply/fabrication.

i) General layout-Plan, section, elevations

ii) Foundation
iii) Wiring-Power & Control

All C.T. to be minimum 15 VA burden and 1.0 accuracy class.

All indicating meters to be of 1.0 accuracy class .

SECTION – 11

DRAWINGS

The contractor shall submit six complete sets of drawings on white paper to the owner/consultants after completion of the work.

These drawings must give the following information, in addition to the information asked for in various other sections of the specifications:

a) Location of L.T. Panels etc.

b) Cable routes clearly indicating the sizes & number of cables.

c) Wiring diagram of L.T. Panels.

d) Complete single line diagram for Normal and Emergency supplies.

e) Any other information the consultants-in-charge may deam fit.

No completion certificate will be issued until the drawings are submitted. The drawings will be prepared and submitted by the contractor without any extra charge.

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APPENDIX - I

TERMINOLOGY

This appendix indicates some of the commonly used and important terms, relevant for the Internal El works.

1. **Exposed conductive part** - A conductive part of electrical equivalent, which can be touched and which is not normally live, but which may become the earth potential.

2. **Direct contact** - Contact of persons or livestock with live parts which may result in electrical shock.

3. **Indirect Contact** - Contact of persons or livestock with exposed conductive parts made live by a fault and which may result in electric shock.

4. **Live Part** - A conductor or conductive part intended to be energized in normal use, including a neutral conductor but, by convention, not a PEN conductor.

5. **Touch Voltage** - The potential difference between a grounded metallic structure and a point on the earth surface separated by a distance equal to the normal maximum horizontal reach of approximately 1 meter.

6. **Danger** - Danger to health or danger to life or limb from shock, burn or injury from mechanical movement to persons (and livestock where present), or from fire attendant upon the use of electrical energy.

7. **Earth** - The conductive mass of the earth, whose electric potential at any point is conventionally taken as zero.

8. **Earth electrode** - A conductor or group of conductors in intimate contact with and providing an electrical connection to earth.

9. **Earth fault loop impedance**- The impedance of the earth fault current loop (phase to earth loop), starting and ending at the point of earth fault.

10. **Earth leakage current** - A current which flows to earth, or to extraneous conductive parts, in a circuit which is electrically sound.

11. **Earth conductor** - A protective conductor connecting the main earth terminal to an earth electrode.

12. **Residual current** - The algebraic sum of the instantaneous values of current flowing through all the live conductors of a circuit at a point of the electrical installation.

13. **Residual current device (RCD)** - A mechanical switching device, intended to cause the opening of the contacts when the residual current attains a given value under the specified conditions.

14. **Switchboard**- An assembly of switchgear with or without instruments, but the term does not apply to a group of local switches in a final circuit.

15. **Switchgear** - An assembly of main and auxiliary switching apparatus for operation, regulation, protection or other control of electrical installations.

APPENDIX-II

SAFETY PROCEDURE

1. The Indian Electricity Rules 1956, as amended upto date, are to be followed in their entirety. Any installation or portion of installation which does not comply with these rules should be got rectified immediately.

2. The detailed instructions on safety procedures given in B.I.S. Code No. 5216-1969-"Code of Safety Procedures and Practices in Electrical Works" shall be strictly followed.

3. No inflammable materials shall be stored in places other than the rooms specially constructed for this purpose in accordance with the provisions of Indian Explosives Act. If such storage is unavoidable, it should be allowed only for a short period and in addition, special precautions, such as cutting off the supply to such places at normal times, storing materials away from wiring and switch boards, giving electric supply for a temporary period with the permission of consultants shall be taken.

4. The electrical switchgears and distribution boards should be clearly marked to indicate the areas being controlled by them.

5. Before energising on an installation after the work is completed, it should be ensured that all tools have been removed and accounted, no person is present inside any enclosure of the switch board etc. any earthing connection made for doing the work has been removed.

APPENDIX-III

LIST OF INDIAN STANDARDS (IS)

IS : 374 - 1979	Ceiling fans and regulators (3rd revision)
IS : 694 - 1990	PVC insulated Electric cable for working voltage upto and including1100 volts.
IS : 732 - 1989	Code of practice for electrical wiring and installation
IS : 1255 - 1983	Code of Practice for installation and maintenance of Power Cables upto and including 33 KV rating (Second Revision)
IS : 1258 - 1987	Bayonet lamp holders(Third revision)
IS : 1293 - 1988	Three pin plugs and sockets outlets rated voltage upto and including 250 volts and rated current upto and including 160 amps.
IS : 1554 - 1988 (Part - I)	PVC insulated (Heavy Duty) electric cables for working voltages upto and including 1100 volts.
IS : 1646 - 1982	Electrical installation fire safety of buildings (general) Code of practice.
IS : 1651 & 1652 - 1991	Stationary cell and batteries, lead acid type
IS : 1885 - 1971	Glossary of items for electrical cables and conductors
IS : 1913 – 1978	General and safety requirements for fluorescent lamps luminaries Tubular.
IS : 2026 – 1977 to 81 (Part-I to IV)	Power Transformer
IS : 2071 - 1974 - 76	Methods of high voltage testing
IS : 2309 - 1989	Protection of building and allied structures against lightning
IS : 2551-1982	Danger notice plate.
IS : 3043 - 1987	Code of practice for earthing.
IS : 3480 - 1966	Flexible steel conduits for electrical wiring.

IS : 3837 - 1976	Accessories for rigid steel conduit for electrical wiring.
IS : 4146 - 1983	Application guide for voltage transformers
IS : 4615 - 1968	Switch socket outlets.
IS : 5133 - 1969 (Part -I)	Boxes for the enclosure of electrical accessories.
IS : 5216 - 1982 (Part-I)	Guide for safety procedures and practices in electrical work.
IS : 5424 - 1969	Rubber mats for electrical purposes.
IS : 5578 & 11353-1985	Marking and arrangement of bus bars
IS : 7098 - 1985 (Part - II)	Cross linked polyethylene insulated PVC sheathed cables. For working voltages from 3.3 KV upto and including 33 KV
IS : 8130 - 1984	Conductors for insulated electric cables and flexible cords
IS : 8623 -1977 (Part -I)	Factory built assemblies of switchgear and control gear for voltages upto and including 1000 V AC and 1200 V D C.
IS : 8623 - 1980 (Part -II)	Bus Bar trunking system
IS : 8828 - 1996	Miniature Circuit Breakers
IS : 9537 - 1981	Rigid Steel Conduits for electrical wiring (Second Revisions)
IS : 10810 - 1988	Methods of test for cables.
IS : 11171 – 1985	Specifications for dry type transformers
IS : 12640 - 1988	Earth Leakage Circuit Breakers
IS : 13947-1989	Moulded Case Circuit Breakers
IS : 13947 - 1993	Degree of protection provided by enclosures for LV switchgear and control gear.
IS : 13947 - 1993	General requirement for switchgear and control gear for voltage not exceeding 1000 Volts.
IS : 1651 & 1652 1991	Stationary cells and batteries lead acid type.

APPENDIX – IV

ABBREVIATIONS

Following abbreviations have been used in the accompanying Specifications, drawings and Schedule of Quantities.

CU	stands for copper.
GI	stands for Galvanized Iron (Mild Steel)
V	stands for Volts
MV	stands for Medium Voltage (110 V ,230 V ,415 V, 600 V)
LV	stands for Low Voltage (32 V & Below)
LT	stands for Low Tension
PVC	stands for Polyvinyl Chloride
AMP	stands for Amperes
KWH	stands for Kilowatt Hours
KW	stands for Kilo Watts
BIS	stands for Bureau of Indian Standards
IS	stands for Indian Standards
IEE	stands for Institution of Electrical Engineers - London
NEC	stands for National Electrical Code
VCB	stands for Vacuum Circuit Breaker
ACB	stands for Air Circuit Breaker
RCCB	stands for Earth Leakage Circuit Breaker
MCB	stands for Miniature Circuit Breaker
MCCB	stands for Moulded Case Circuit Breaker
SP	stands for Single Pole
DP	stands for Double Pole
TP	stands for Triple Pole
TPN	stands for Triple Pole and Neutral
4 Pole	stands for 3 phase and neutral of same capacity (size)
MDB	stands for Main Distribution Board
SDB	stands for Sub Distribution Board
FDB	stands for Final Distribution Board
MCC	stands for Motor Control Centre

APPENDIX V

SCHEDULE OF DEPARTURE FROM SPECIFICATIONS

Section	Ref. to Clause of the Specification	Description of departure	Reason for departure	Remarks
(1)				
(2)				
(3)				
(4)				

Certified that except for the departures mentioned above, the tender is in accordance with CPWD General Specifications for Electrical Works (Part VI Fire Alarm System) 1988 and in a accordance with detailed requirements specified to the tender specifications.

Signature of the Tenderer