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Technical Specifications

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TECHNICAL SPECIFICATIONS - Civil

1.1. GENERAL

1.1.1. The following Technical specifications, code of practice etc. referred herein form a part of the Item Specifications and work shall be executed accordingly. Items which are not covered under Technical Specification shall be carried out as per relevant IS Specifications or as per manufacturer's specifications or as directed by Engineer-in-charge.

1.1.2. In case of discrepancy between Technical specification and Item specifications provided along with Bill of Quantities, the Item Specification shall prevail.

1.1.3. All the measurements shall be as per latest edition of B.I.S.

1.2. EARTH WORK

1.2.1. Applicable Codes

1.2.1.1. The following Indian Standard Codes, unless otherwise specified herein, shall be applicable. In all cases, the latest revision of the codes shall be referred to.

a) IS4081: Safety code for blasting and related drilling operation.
b) IS1200: Method of measurement of building works.
c) IS3764: Safety code for excavation work.
d) IS3385: Code of practice for measurement of Civil Engineering works.
e) IS2720: Part II Determination of moisture content.
Part VIII Determination of moisture content dry density relation using light compaction.
Part XXVIII Determination of dry density of soils, in-place by the sand replacement method.
Part XXIX Determination of dry density of soils, in-place, by the core-cutter method.

1.2.2. General

1.2.2.1. The Contractor shall carry out the survey of the site before excavation and set properly all lines and establish levels for various works such as earthwork in excavation for levelling, basement, foundations, plinth filling, roads, drains, cable trenches, pipelines, etc. It is necessary to establish permanent benchmark at such point which will not be affected by subsequent work. Such survey shall be carried out by taking accurate cross sections of the area perpendicular to the established reference/grid lines at 5 m intervals or nearer as determined by the Engineer-in-charge based on ground profile.

1.2.2.2. The area to be excavated /filled shall be cleared of fences, trees, plants, logs, slumps, bush, vegetations, rubbish slush, etc., and other objectionable matter. If any roots or stumps of trees are found during excavation, they shall also be removed. The material so removed shall be burnt or disposed off as directed by the Engineer-in-charge. Where earth fill is intended, the area shall be stripped of all loose/soft patches, top soil containing deleterious matter/materials before fill commences.

1.2.2.3. In firm soil if the excavation is deeper than 2 m and in loose, soft or slushy soil, the width of the step shall be suitably increased or the sides sloped or shoring and strutting may be done as per the instructions of the Engineer-in-charge without any extra cost.

1.2.2.1. For excavation in trenches for pipes, nothing extra shall be payable for the lift irrespective of the depth unless specifically mentioned otherwise in the Schedule of Quantities.

1.2.2.5. The trenches which are ready for concreting shall be got approved by the Engineer-in-charge.

1.2.2.6. The excavated stacked earth shall be refilled in the trenches and sides of foundation in 200 mm layers and the balance surplus shall be first filled in layers in plinth and the remaining surplus shall be disposed of by uniform spreading within the site/outside the site as directed by the Engineer-in-charge.

1.2.2.7. Adequate protective measures shall be taken by the Contractor to see that the excavation for the building foundation does not affect the adjoining structure's stability and safety. The Contractor will be held responsible if he has not taken precaution for the safety of the people, workers property or neighbour's property caused by his negligence during the execution of the project.

1.2.3. Classification

Any earthwork will be classified under any of the following categories:

1.2.1. All kinds of soils

These shall include all kinds containing kankar, sand, silt, moorum and/or shingle, gravel, clay, loam peat, ash, shale, etc., which can generally be excavated by spade, pick-axe and shovel and which is not classified under soft and decomposed rock, and hard rock defined below. This shall also include embedded rock boulders not bigger than 1 metre in any dimension and not more than 200 mm in any one of the other two dimensions. These shall also include rock, boulders, slag, chalk, slate, hard mica schist, laterite etc., which are to be excavated with or without blasting or could be excavated with picks, hammer, crow bars, wedges. This shall also include excavation in macadam and tarred roads and pavements. This shall also include rock boulders not bigger than 1 metre in any dimension and not more than 500 mm in any one of the other two dimensions Rubble masonry to be dismantled will also be measured under this item.

1.2.5. Hard Rock

This shall include rock which cannot be easily excavated with pick-axes, hammer, crow bars and wedges but has to be either heated where blasting is prohibited or has to be blasted. They shall be stacked separately for measurement as directed by the Engineer-in-charge.

1.2.6. Lead

Lead for disposal of excavated material inside the site and at convenient places in the surrounding areas have been specified in the respective items of work and no other extra lead is intended.

1.2.7. Earth work in excavation in rocks

1.2.7.1. Unless otherwise stated herein, IS 4081, safety code for blasting and related drilling operations shall be followed. After removal of over burden, if any, excavation shall be continued in rock to such widths, lengths, depths and profiles as are shown on the drawings or such other lines and grades as may be specified by the Engineer-in-charge. As far as possible all blasting shall be completed prior to commencement of construction. At all stages of excavation, precautions, shall be taken to preserve the rock below and beyond the lines specified for the excavation, in the soundest possible condition. The quantity and strength of explosives used shall be such that it will neither damage nor crack the rock outside the limits of excavation. All precautions, as directed by the Engineer-in-charge shall be taken during the blasting operations and care shall be taken that no damage is caused to adjoining buildings or structure as a result of blasting operations. In case of damage to permanent or temporary structures, the Contractor shall repair the same to the satisfaction of Engineer-in-charge at his cost. As excavation approaches its final lines and levels, the depth of the charge holes and amount of explosives used shall be progressively and suitably reduced.

1.2.7.2. Specific permission of the Engineer-in-charge will have to be taken by the Contractor for blasting rock and he shall also obtain a valid blasting licence from the authorities concerned. If permission for blasting is refused by the Engineer-in-charge, the rock shall be removed by wedging, pick barring, heating and quenching or other approved means. All loose/loosened rock in the sides shall be removed by barring wedging, etc. The unit rates for excavation in hard rock shall include the cost of all these operations.

1.2.7.3. Contractor shall employ a competent and experienced supervisor and licensed blaster in charge for each set of operation, who shall be held personally responsible to ensure that all safety regulations are carried out.

1.2.7.1. Before any blasting is carried out, the Contractor shall intimate the Engineer-in-charge and obtain his approval in writing for resorting to such operations. He shall intimate the hours of firing charges, the nature of explosives to be used and the precautions taken for ensuring safety.

1.2.8. Filling in plinth with selected excavated earth

1.2.8.1. Plinth shall be filled in layers 15-30 cm, of thickness or as specified in Items specification watered and compacted with hand rammers as directed by the Engineer-in-charge, so as to avoid any settlement at later stage. For the final layer the surface shall be flooded with water and water allowed to stand for 24 hours. The finished level of the filling shall be trimmed to the level specified.

1.2.8.2. Where specified in the Item description given in the Schedule of Quantities that the compaction of the plinth fill shall be carried out by means of 10/12 tonnes rollers smooth wheeled, sheep-foot or wobble wheeled rollers. As rolling proceeds, water

sprinkling shall be done to assist consolidation. Water shall not be sprinkled in case of sandy fill.

1.2.9. Filling excavated earth in ground for land development

1.2.9.1. No earth fill shall commence until surface water discharges and streams have been properly intercepted or otherwise dealt with as directed by the Engineer-in-charge.

1.2.9.2. Filling shall be carried out as indicated in the drawings and as directed by the Engineer-in-charge. If no compaction is called for, the fill may be deposited to the full height in one operation and levelled. If the fill has to be compacted, it shall be placed in layers not exceeding 600 mm and levelled uniformly and compacted before the next layer is deposited.

1.2.9.3. As and when field compaction is called for, test shall be carried out at different stages of filling and also after the fill to the entire height has been completed. This shall hold good for embankments as well. The tests for field compaction shall be specified by the Engineer-in-charge and the Contractor shall arrange to carry out such tests to the satisfaction of the Engineer-in-charge.

1.2.9.1. Contractor shall protect the earth fill from being washed away by rain or damaged in any other way. Should any slip occur, the Contractor shall remove the affected material and make good the slip at his own cost.

1.2.9.5. The fill shall be carried out to such dimensions and levels as indicated on the drawings after the stipulated compaction. The fill shall be considered as incomplete if the desired compaction has not been obtained.

1.2.10. Filling in plinth and ground with earth brought from outside

1.2.10.1. Filling shall be carried out with the approved material. The material and source shall be subject to prior approval of the Engineer-in-charge. The approved area, from where the fill material is to be dug, shall be cleared of all bushes, roots plants, rubbish, etc., top soil containing salts, sulphate and other foreign material shall be removed. The materials so removed shall be burnt or disposed off as directed by the Engineer-in-charge. The Contractor shall make necessary access roads to those areas and maintain the same, if such an access road does not exist, at his cost.

1.2.10.2. If any material is rejected by the Engineer-in-charge, Contractor shall remove the same forthwith from the site at no extra cost to the owner. Surplus fill material shall be disposed of by uniform spreading within the site as instructed by the Engineer-in-charge.

1.2.10.3. At places where backfilling is required, the same shall be carried out with local sand if directed by Engineer-in-charge. The sand used shall be kept flooded with water for 24 hours to ensure maximum consolidation. Any temporary work required to contain sand under flooded condition shall be to Contractor’s account. The surface of the consolidated sand shall be dressed to require level or slope. Construction of floors or

other structures on sand fill shall not be started until the Engineer-in-charge has inspected and approved the fill.

1.3. BORED CAST-IN-SITU PILE FOUNDATION

1.3.1. The tenderer has to acquaint himself with the site condition before tendering for the work.

1.3.2. The contractor shall be responsible for the correctness of location of pile points as given with the pile layout drawing which will be supplied to the contractor. If any lateral shift or tilt of the pile is noticed, the contractor will have to drive alternate pile at his own cost as directed by the Engineer-in-charge whose decision shall be final. Any excess quantity of RCC pile cap if necessitated due to driving such alternate pile will have to be done by the contractor, at his own cost.

1.3.3. Piles have to be socketed in hard rock by 500mm.

1.3.1. The length of pile for payment shall be from bottom of the pile cap to the bottom tip of pile.

1.3.5. Concreting of pile shall be done up to ground level and later chipped off up to cut-off level by the contractor. Charges for these shall be deemed to have been included in the rate quoted for piling.

1.3.6. Main steel of piles shall be kept projecting from the top to the extent of 50 times the diameter of the bar for use as dowels in pile cap/grade beam.

1.3.7. Cement and steel to be used on the work shall conform to prevailing IS standards.

1.3.8. Any ground with high water table or in soft soil having unstable pile bores, boring and under ream may be carried out with suitable drilling works.

1.3.9. The bentonite suspension used for piling work shall satisfy the following requirements:

1.3.10. The liquid limit of bentonite when tested in accordance with IS2720 (Part V) 1965 shall be more than 300 percent and less than 450 percent.

1.3.11. The sand content of the bentonite powder shall not be greater than 7 percent.

1.3.12. Bentonite solution should be made by mixing it with fresh water using pump for circulation. The relative density of the bentonite solution should be about 1.12.

1.3.13. Concreting shall be done as soon as possible after completing the pile bore. The bore hole full of drilling mud should not be left unconcreted for more than 12 to 24 hours depending upon the stability of bore hole.

1.3.11. For placing concrete in pile bores, a funnel should be used and method of concreting should be such that the entire volume of the pile bore is filled up without the formations of voids and/or mixing of soil and drilling fluid in the concrete.

1.3.15. In the empty bore holes for piles a small quantity of concrete is poured to give about a 100 mm layer of concrete at the bottom. Reinforcement is lowered next and positioned correctly. Then concrete is poured to fill up the bore hole. Care should be taken that soil is not scrapped from sides if rodding is done for compaction. Vibrators shall not be used.

1.3.16. In case the pile bore is stabilized with drilling mud or by maintaining water head within the bore hole, the bottom of bore hole shall be carefully cleaned by flushing it with fresh drilling mud, and pile bore will be checked for its depth immediately before concreting.

1.3.17. Concreting shall be done by tremie method. The tremie should have a valve at its bottom and lowered with its valve closed at the start and filled up with concrete. The valve is then opened to permit the flow of concrete which permits the upward displacement of drilling mud. The pouring should be continuous and tremie is gradually lifted up such that the tremie pipe opening remains always in the concrete. In the final stage the quantity of concrete in tremie should be enough so that on final withdrawal some concrete spills over the ground.

1.3.18. The work shall be done as per IS2911 (Part I/Section II) 1979 latest edition.

1.1. CONCRETE AND ALLIED WORKS

1.1.1. Applicable Codes

1.1.1.1. The following codes and standards are made a part of the Specifications. All standards, codes of practices referred to herein shall be the latest edition including all applicable official amendments and revisions.

1.1.1.2. In case of discrepancy between this specification and those referred to herein, this specification shall prevail.

1.1.2. Materials

a) IS 269: Specification for ordinary, rapid hardening and low heat Portland cement

b) IS 455: Specification for Portland blast furnace slag.

c) IS 1489: Specification for Portland-Pozzolana cement

d) IS 4031: Methods of physical tests for hydraulic cement

e) IS 650: Specification for standard sand for testing of cement

f) IS 383:Specification for coarse and fine aggregates from natural sources for concrete

g) IS 2386: (Parts I to VIII): Methods of test for aggregates for concrete

h) IS 516: Methods of test for strength of concrete

i) IS 1199: Methods of sampling and analysis of concrete

j) IS 2396 (I) IS 5640: Flakiness Index of aggregates

k) IS 3025: Methods of sampling and test (physical and chemical water used in industry)

l) IS 432(Part I & II): Specification for mild steel and medium tensile steel bars and hard drawn steel wire for concrete reinforcement

m) IS 1139: Specification for hot rolled mild steel and medium tensile steel deformed bars for concrete reinforcement

n) IS 1566: Specification for plain hard drawn steel wire fabric for concrete reinforcement

o) IS 1785: Specification for plain hard drawn (Part I) steel wire for pre-stressed concrete

p) IS 1786: Specification for cold twisted steel bars for concrete reinforcement

q) IS 2090: Specification for high tensile steel bars used in pre-stressed concrete

r) IS 4990: Specification for plywood for concrete shuttering work

s) IS 2645: Specification for integral cement water-proofing compounds

1.1.3. Equipment

a) IS 1791: Specification for batch type concrete mixers

b) IS 2438: Specification for roller pan mixer

c) IS 2505: Specification for concrete vibrators immersion type

d) IS 2506: Specification for screed board concrete vibrators

e) IS 2514: Specification for concrete vibrating tables

f) IS 3366: Specification for pan vibrators

g) IS 4656: Specification for form vibrators for concrete

h) IS 2722: Specification for portable swing weigh-batchers for concrete (single and double bucket type)

i) IS 2750: Specification for steel scaffoldings

1.1.1. Codes of Practice

a) IS 456: Code of practice for plain and reinforced concrete

b) IS 1343: Code of practice for pre-stressed concrete

c) IS 457: Code of practice for general construction of plain and reinforced concrete for dams and other massive structures

d) IS 3370 (Part I to IV): Code of practice for concrete structures for storage of liquids.

e) IS 3935: Code of practice for composite construction

f) IS 3201: Criteria for design and construction of precast concrete trusses

g) IS 2204: Code of practice for construction of reinforced concrete shell roof

h) IS 2210: Criteria for the design of RC shell structures and folded plates

i) IS 2751: Code of practice for welding of mild steel bars used for reinforced concrete construction

j) IS 2502: Code of practice for bending and fixing of bars for concrete reinforcement

k) IS 3558: Code of practice for use of immersion vibrators for consolidating concrete

l) IS 3414: Code of practice for design and installation of joints in buildings

m) IS 4014 (Part I&II): Code of practice for steel tubular, scaffolding

n) IS 2571: Code of practice for laying in-situ cement concrete flooring

1.1.5. Construction Safety

IS 3696: Safety code for scaffolds and ladders

1.1.6. Measurement

IS 1200: Method of measurement of building works

IS 3385: Code of practice for measurement of civil engineering works

1.1.7. General

1.1.7.1. The quality of materials, method and control of manufacture and transportation of all concrete work irrespective of mix, whether reinforced or otherwise shall conform to the applicable portions of this specification.

1.1.8. Materials

1.1.8.1. The ingredients to be used in the manufacture of standard concrete shall consist solely of standard type Portland cement, clean sand, natural coarse aggregate, clean water and admixtures.

1.1.9. Cement

1.1.9.1. If the Contractor is instructed to supply cement, then the following points shall be applicable:

1.1.9.2. Unless otherwise specified the cement shall be ordinary Portland cement in 50 kg bags. The use of bulk cement will be permitted only with the approval of the Engineer-in-charge.

1.1.9.3. A certified report attesting to the conformance of the cement to IS specifications by the cement manufacturer's chemist shall be furnished to the Engineer-in-charge if demanded.

1.1.9.1. Cement held in storage for a period of sixty (60) days or longer shall be tested. Should at any time the Engineer-in-charge have reasons to consider that any cement is defective, then irrespective of its origin, and/or manufacturers test certificate, such cement shall be tested immediately at the Contractor's cost at an approved laboratory and until the results of such tests are found satisfactory, it shall not be used in any work. The Contractor shall not be entitled to any claim of any nature on this account.

1.1.9.5. If the cement is supplied by the Client, Contractor will have to make his own arrangements for the storage of cement. If supplies are arranged by owner, cement will be issued in quantities to cover work requirements of one month or more, as deemed fit by the Engineer-in-charge and it will be the responsibility of the Contractor to ensure adequate and proper storage. The storage arrangements shall be such that there is no dead storage. The storage arrangement shall be approved by the Engineer-in-charge.

1.1.10. Aggregates

1.1.10.1. Aggregate in general designates both fine and coarse inert materials used in the manufacture of concrete. Fine aggregate is aggregate all of which passes through 1.75 mm IS sieve. Coarse aggregate is aggregate most of which is retained on 1.75 mm sieve. Specification mentioned against various item of work may also be followed.

1.1.10.2. All fine and coarse aggregates proposed for use in the work shall be subject to the approval of the Engineer-in-charge and after specific materials have been accepted,

the source of supply of such materials should not be changed without prior approval of the Engineer-in-charge.

1.1.10.3. Aggregates shall, except as noted above, consist of natural sands, crushed stone and gravel from a source known to produce satisfactory aggregate for concrete and shall be chemically inert, strong, hard, durable against weathering, of limited porosity and free from deleterious materials that may cause corrosion of the reinforcement or may impair the strength and/or durability of concrete. The grading of aggregates shall be such as to produce a dense concrete of specified strength and consistency that will work readily into position without segregation and shall be based on the mix design and preliminary tests on concrete specified later.

1.1.11. Sampling and testing

1.1.11.1. Samples of the aggregates for mix design and determination of suitability shall be taken under the supervision of the Engineer-in-charge and delivered to the laboratory, well in advance of the scheduled placing of concrete. Records of tests which have been made on proposed aggregates and on concrete made from this source of aggregates shall be furnished to the Engineer-in-charge in advance of the work for use in determining aggregate suitability. The costs of all such tests, sampling, etc., shall be borne by the Contractor.

1.1.12. Storage of Aggregates

1.1.12.1. All coarse and fine aggregates shall be stacked in stock separately in stock piles in the materials yard near the work site or if instructed in bins properly constructed to avoid inter mixing of different aggregates. Contamination with foreign materials and earth during storage and while heaping the materials shall be avoided. The aggregate must be of specified quality not only at the time of receiving at site but more so at the time of loading into mixer.

1.1.13. Screening and Washing

1.1.13.1. Sand shall be prepared for use for such screening or washing, or both, as necessary, to remove all objectionable foreign matter while separating the sand grains to the required size fractions.

1.1.13.2. Natural gravel and crushed rock shall be screened and/or washed for the removal of dirt or dust coating, if so demanded by Engineer-in-charge.

1.1.11. Water

1.1.11.1. Water used for both mixing and curing shall be free from injurious amounts of deleterious materials. Potable waters are generally satisfactory for mixing and curing concrete.

1.1.11.2. In case of doubt, the suitability of water for making concrete shall be ascertained by the compressive strength and initial setting time test specified in IS456. The sample of water taken for testing shall be typical of the water proposed to be used for concreting, due account being paid to seasonal variation. The sample shall not

receive any treatment before testing other than that envisaged in the regular supply of water proposed for use in concrete. The sample shall be stored in a clean container previously rinsed out with similar water.

1.5. BRICK AGGREGATES

1.5.1.1. The brickbats shall be of new bricks well burnt, hard, durable and broken to sizes, well graded. It shall be free from dust and the size shall be of 37 mm and down. It shall be free from earth and other impurities.

1.6. MIX DESIGN

1.6.1. In case of concrete works, mix design may be necessary as per IS456 for certain items as decided by the Engineer-in-charge. All concrete in the works shall be of design mix as defined in IS 456, unless it is a nominal mix concrete such as 1:3:6, 1:4:8, 1:5:10.

1.6.2. It shall be very clearly understood that whenever the class of concrete such as M 20 is specified, it shall be the Contractor's responsibility to ensure that minimum crushing strength stipulated for the respective class of concrete is obtained at works. The maximum total quantity of aggregate by weight per 50 kg of cement shall not exceed 250 kg except when otherwise specifically permitted by Engineer-in-charge.

1.6.3. To fix the grading of aggregates, water cement ratio, workability and the quantity of cement required to give test cubes of the minimum strength specified, the proportions of the mix shall be determined by weight. Adjustment of aggregate proportions due to moisture present in the aggregate shall be made. Mix proportioning shall be carried out according to Indian Standard Specifications.

1.6.1. Whenever there is a change either in the required strength of concrete or the water-cement ratio or workability or the source of aggregates and/or cement, preliminary tests shall be repeated to determine the revised proportions, of the mix to suit the altered conditions.

1.6.5. While fixing the value for water-cement ratio for preliminary mixes, assistance may be derived from the graph (appendix IS456) showing the relationship between the 28 day compressive strengths of concrete mixes with different water cement ratios and the 7 days compressive strength of cement tested in accordance with IS269.

1.6.6. Preliminary tests

1.6.6.1. Test specimens shall be prepared with at least two different water-cement ratios for each class of concrete, consistent with workability required for the nature of the work. The materials and proportions used in making preliminary tests shall be similar in all respects to those to be actually employed in the works as the object of these tests is to determine the proportions of cement, aggregates and water necessary to produce concrete of required consistency and to give the specified strength. It will be the Contractor's sole responsibility to carry out these tests and he shall therefore furnish to the Engineer-in-charge, a statement of proportions proposed to be used for the various concrete mixes.

1.6.6.2. Materials shall be brought to the room temperature and all materials shall be in a dry condition. The quantities of water, cement and aggregates for each mix shall be determined by weight/volume to an accuracy of 1 part in 1000 parts.

1.6.6.3. Mixing shall be done by a mixer machine as per IS516 in such a manner as to avoid loss of water. The cement and fine aggregate shall first be mixed dry until the mixture is uniform in colour. The coarse aggregate shall then be added, mixed and water added and mixed thoroughly for a period of not less than 3 minutes until the resulting concrete is uniform in appearance. Each mix of concrete shall be of such a quantity as to leave about 10% excess concrete after moulding the desired number of test specimens.

1.6.6.1. The consistency of each mix of concrete shall be measured immediately after mixing, by the slump test in accordance with IS 1199. If in the slump test, care is taken to ensure that no water or other materials is lost, the materials used for the slump test may be remixed with the reminder of the concrete for making the specimen test cubes. The period of remixing shall be as short as possible yet sufficient to produce a homogeneous mass.

1.6.6.5. Compression tests of concrete cubes shall be made as per IS516 on 15 cm cubes. Each mould shall be provided with a metal base having a plane surface so as to support the mould during filling without leakage. The base plate shall be preferably attached to the mould by springs or screws. The parts of the mould when assembled shall be positively and rigidly held together. Before placing concrete the mould and base plate shall be cleaned and oiled. The dimensions and internal faces of the mould shall be accurate within the following limits:

1.6.6.6. Height and distance between the opposite faces of the mould shall be of specified size plus or minus 0.2 mm. The angle between the adjacent internal faces and between internal faces and top and bottom planes of mould shall be 90 Degree plus or minus 5 Degree. The interior faces of the mould shall be plane surfaces with a permissible variation 0.03 mm.

1.6.6.7. Concrete test cubes shall be moulded by placing fresh concrete in the mould and compacted as specified in IS516.

1.6.6.8. Curing shall be as specified in IS516. The cubes shall be kept in moist air of at least 90% relative humidity at a temperature of 27 Degree Centigrade plus or minus 2 Degree Centigrade for 24 hours plus or minus half hour from the time of adding water to the dry ingredients. Thereafter they shall be removed from the moulds and kept immersed in clean, fresh water and kept at 27 Degree Centigrade plus or minus 2 Degree Centigrade temperature until required for test. Curing water shall be renewed every seven days. A record of maximum and minimum temperatures at the place of storage of the cubes shall be maintained during the period they remain in storage.

1.6.6.9. Testing of specimens

1.6.6.9.1. The strength shall be determined based on not less than five cubes test specimens for each age and each water cement ratio. All these laboratory test results shall be tabulated and furnished to the Engineer-in-charge. The test results shall be accepted by the Engineer-in-charge if the average compressive strengths of the specimens are tested subject to the condition that only one out of the five consecutive

tests may give a value less than the specified strength for that age. The Engineer may direct the Contractor to repeat the tests if the results are not satisfactory and also to make such changes as he considers necessary to meet the requirements specified. All these preliminary tests shall be conducted by the Contractor at his own cost in an approved laboratory.

1.6.7. Proportioning, consistency, batching and mixing of concrete

1.6.7.1. Aggregate

The proportions which shall be decided by conducting preliminary tests shall be by volume. These proportions of cement, fine and coarse aggregates shall be maintained during subsequent concrete mixing. The supply of properly graded aggregate of uniform quality shall be maintained over the period of work, the grading of aggregates shall be controlled by obtaining the coarse aggregate in different sizes and blending them in the right proportions. The different sizes shall be stocked in separate stock piles. The grading of coarse and fine aggregate shall be checked as frequently as possible as determined by the Engineer-in-charge, to ensure maintaining of grading in accordance with the samples used in the preliminary mix design. The material shall be stock piled well in advance of use.

1.6.8. Cement

1.6.8.1. The cement shall be measured by weight.

1.6.9. Water

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

1.6.9.2. The water cement (W/C) ratio will be decided by Engineer-in-charge on weight basis and this shall be strictly followed at site.

1.6.10. Proportioning by Water/Cement ratio

1.6.10.1. The W/C ratio specified for use by the Engineer-in-charge shall be maintained. The Contractor shall determine the water content of the aggregates as frequently as directed by the Engineer-in-charge as the work progress and as specified in IS 2386 (Part-III) and the amount of water added at the mixer shall be adjusted as directed by the Engineer-in-charge so as to maintain the specified W/C ratio. To allow for the variation in volume of aggregates due to variation in their moisture content suitable adjustments in the volume of aggregates shall also be made.

1.6.11. Consistency and slump

1.6.11.1. Concrete shall be of a consistency and workability suitable for the conditions of the job. After the amount of water required is determined, the consistency of the mix shall be maintained throughout the progress of the corresponding parts of the work and

approved tests e.g. slump tests, compacting factor tests, in accordance with IS 1199 shall be conducted from time to time to ensure the maintenance of such consistency.

Placing Conditions	Degree of Workability	Slump (mm)
Blinding concrete: Shallow sections; Pavements using pavers	Low	25-75
Mass concrete: Lightly reinforced sections in slabs, beams, walls, columns:Floors; Hand placed pavements; Canal lining; Strip footings	Medium	50-100
Heavily reinforced sections in slabs, beams, walls, columns;Slip formwork;	High	75-100
Pumped concrete ,Trench fill;*In-situ pilling, Tremie concrete*	Very high	100-150

1.6.11.2. Slumps for Various Types of Construction

1.6.11.3. **Only** sufficient quantity of water shall be added to concrete during the mixing to produce a mix of sufficient workability to enable it to be well consolidated, to be worked into the corners of the shuttering and around the reinforcement, to give the specified surface finish, and to have the specified surface strength. The following slumps shall be adopted for different kinds of works:

1.6.12. Sampling and testing concrete in the field

1.6.12.1. Facilities required for sampling materials and concrete in the field shall be provided by the Contractor at no extra cost. The following equipment with operator shall be made available at Engineer's request (all must be in serviceable condition):

a) One concrete cube testing machine suitable for 15 cm cubes of 100 tonnes capacity with proving calibration ring.

b) Twelve cast iron cube moulds of 15 cm size

c) One Lab. balance to weigh up to 5 kg with sensitivity of 10 gm.

d) One set of sieves for coarse and fine aggregates

e) One set of slump cone complete with tamping rod.

f) A set of measures from 5 litres to 0.1 litre.

g) One electric oven with thermostat up to 120 Degree Centigrade.

h) One flakiness gauge

i) One elongation index gauge

j) One sedimentation pipette

k) One Pyconometer

l) Two calibrated glass jar of 1 litre capacity

1.6.12.2. Arrangement can be made by the contractor to have the cubes tested in an approved laboratory in lieu of a testing machine at site at his expense, with the prior consent of the Engineer-in-charge.

1.6.12.3. At least 6 test cubes of each class of concrete shall be made for every 15.0 cum of concrete or part thereof. Such samples shall be drawn on each day for each type of concrete. Of each set of 6 cubes, three shall be tested at 7 days age and three at 28 days age. The laboratory test results shall be tabulated and furnished to Engineer-in-charge. The Engineer-in-charge will pass the concrete if average strength of the specimens tested is not less than the strength specified, subject to the condition that only one out of three consecutive tests may give a value less than the specified strength but this shall not be less than 90% of the specified strength. The cubes shall be tested on 7th and 28th day from the day of casting of the cubes.

1.6.13. Admixtures

Admixtures may be used in concrete only with the approval of the Engineer-in-charge based upon evidence that, with the passage of time, neither the compressive strength nor its durability reduced. **Calcium chloride shall not be used for accelerating setting of the cement for any concrete containing reinforcement, or embedded steel parts**. When calcium chloride is permitted to be used, such as in mass concrete works, it shall be dissolved in water and added to the mixing water in an amount not to exceed 1.5% of the volume of the cement in concrete. When admixtures are used, the designed concrete mix shall be corrected accordingly. Admixtures shall be used as per manufacturer's instructions and in the manner and within the control of the Engineer-in-charge.

1.6.11. Air entraining agents

Where specified and approved by the Engineer-in-charge, neutralised vinyl resin or any other approved air-entraining agent may be used to produce the specified amount of air in the concrete mix and these agents shall conform to the requirements of ASTM standard 6260, air entraining admixtures for concrete. The recommended total air content of the concrete is 4% plus or minus 1%. The method of measuring air content shall be as per IS1199.

1.6.15. Water reducing admixtures

Where specified and approved by the Engineer-in-charge water reducing lignosulfonate mixture shall be added in quantities specified by the Engineer-in-charge. The admixtures shall be added in the form of a solution.

1.6.16. Retarding admixtures

Where specified and approved by Engineer-in-charge retarding agents shall be added to the concrete mix in quantities specified by the Engineer-in-charge.

1.6.17. Water proofing agent

Where specified and approved by the Engineer-in-charge, water proofing agent conforming to IS 2645 shall be added in quantities specified by Engineer-in-charge

1.6.18. Optional tests

1.6.18.1. The Engineer-in-charge may order tests to be carried out on cement, sand, coarse aggregate and water in accordance with the relevant Indian Standards. Tests on cement shall include (i) fineness test (ii) test for normal consistency (iii) test for setting time (iv) test for soundness (v) test for tensile strength (vi) test for compressive strength (vii) test for heat of hydration by experiment and by calculations in accordance with IS 269. Tests on sand shall include (i) sieve test (ii) test for organic impurities (iii) decantation test for determining clay and silt content (iv) specific gravity test (v) test for unit weight and bulkage factor. Tests on coarse aggregate shall include (i) test for sieve analysis (ii) specific gravity and unit weight of dry loose and rodded aggregate (iii) soundness and alkali aggregate reactivity (iv) petro graphic examination (v) deleterious materials and organic impurities (vi) test for aggregate crushing value. Any or all these tests would normally be ordered to be carried out only if the Engineer-in-charge feels the materials are not in accordance with the specifications or if the specified concrete strengths are not obtained and shall be performed by contractor at site or at an approved test laboratory.

1.6.18.2. If the work cubes do not give the stipulated strengths the Engineer-in-charge reserves the right to ask the Contractor to dismantle such portions of the work which in his opinion are unacceptable and re-do the work to the standard stipulated at contractor's cost.

1.6.19. Preparation prior to concrete placement

1.6.19.1. Before the concrete is actually placed in position, the insides of the form work shall be inspected to see that they have been cleaned and oiled. Temporary openings shall be provided to facilitate inspection, especially at bottom of columns and walls forms to permit removal of saw dust, wood shavings, binding wire, rubbish dirt, etc. Openings shall be placed or holes drilled so that these materials and water can be removed easily. Such openings/holes shall be later suitably plugged.

1.6.19.2. The various agencies shall be permitted ample time to install drainage and plumbing lines in floor and trench drains, conduits, hangers, anchors, inserts, sleeves, bolts, frames and other miscellaneous embediments to be cast in the concrete as indicated on the drawings or as is necessary for the proper execution of the work. The Contractor shall cooperate fully with all such agencies and shall permit the use of scaffolding form work, etc., by other agencies at no extra cost.

1.6.19.3. All embedded parts, inserts, etc., supplied by Owner or Contractor shall be correctly positioned and securely held in the forms to prevent displacement during depositing and vibrating of concrete.

1.6.19.1. Anchor bolts shall be positioned and kept in place with the help of properly manufactured templates. The use of all such templates, fixture, etc., shall be deemed to be included in the rates.

1.6.19.5. Slots, openings, holes, pockets, etc., shall be provided in the concrete work in the positions indicated in the drawings or as directed by the Engineer-in-charge.

1.6.19.6. Prior to concrete placement all work shall be inspected and approved by the Engineer-in-charge and if found unsatisfactory, the concrete shall not be poured until after all defects have been corrected at the Contractor's cost. Cat ladders shall be provided on the reinforcement to facilitate labour movement.

1.6.19.7. Approval by the Engineer-in-charge for all materials and work as required herein shall not relieve the Contractor from his obligation to produce finished concrete in accordance with the drawings and specifications.

1.6.19.8. No concrete shall be placed in wet weather or on water covered surface. Any concrete that has been washed by heavy rains, the work shall be entirely removed, if there is any sign of cement and having been washed from the concrete mixture. To guard against damage which may be caused by rains, the works shall be covered with tarpaulins immediately after the concrete has been placed and compacted. Any water accumulating on the surface of the newly placed concrete shall be removed by approved means and no further concrete shall be placed thereon until such water is removed. To avoid flow of water over/around freshly placed concrete, suitably drains and sumps shall be provided.

1.6.19.9. Immediately before concrete placement begins, proposed surfaces except framework, which will come in contact with the concrete to be placed, shall be covered with a bonding mortar.

1.6.20. Transportation

1.6.20.1. All buckets, containers or conveyors used for transporting concrete shall be mortar tight. Irrespective of the method of transportation adopted, concrete shall be delivered with the required consistency and plasticity without segregation or loss of slump. However, chutes shall not be used for transport of concrete without the written permission of the Engineer-in-charge and the concrete shall not be re-handled before placing.

1.6.20.2. Concrete must be placed in its final position before it becomes too stiff to work. On no account, water shall be added after the initial mixing concrete which has become stiff or has been contaminated with foreign materials shall be rejected and disposed off as directed by the Engineer-in-charge.

1.6.20.3. All equipment used for mixing, transporting and placing of concrete shall be maintained in clean condition. All pans, buckets, hoppers, chutes, pipelines and other equipment shall be thoroughly cleaned after each period of placement.

1.6.21. Procedure for placing of concrete

1.6.21.1. Before any concrete is placed, the entire placing programme, consisting of equipment, layout proposed procedures and methods shall be submitted to the Engineer-in-charge for approval if so demanded by the Engineer-in-charge and no concrete shall be

placed until approval of the Engineer-in-charge has been received. Conveyor for conveying concrete shall be of such size and design as to ensure a practically continuous flow of concrete during depositing without segregation of materials, considering the size of the job and placement location.

1.6.21.2. Concrete shall be placed in its final position before the cement shall normally be compacted in its final position within thirty minutes of leaving the mixer and once compacted it shall not be disturbed.

1.6.21.3. Concrete, in all cases, be deposited as nearly as practicable directly in its final position, and shall not be re-handled or caused to flow in a manner which will cause segregation, loss of materials, displacement of reinforcement, shuttering or embedded inserts or impair its strength. For locations where direct placement is not possible, and in narrow forms, contractor shall provide suitable drop and elephant trunks to confine the movement of concrete. Special care shall be taken when concrete is dropped from a height especially if reinforcement is in the way, particularly in columns and thin walls

1.6.21.1. Except when otherwise approved by Engineer-in-charge, concrete shall be placed in shovels or other approved implements and shall not be dropped from a height more than 1 M or handled in a manner which will cause segregation.

1.6.21.5. The following specifications shall apply when placing of concrete by use of mechanical equipment is specifically called for while inviting bids or is warranted considering the nature of work involved. The control of placing shall begin at the mixer discharger, concrete shall be discharged by a vertical drop into the middle of the bucket or hopper and this principle of a vertical discharge of concrete shall be adhered to thoroughly all stages of delivery until the concrete comes to rest in its final position.

1.6.21.6. Central bottom dump buckets of a type that provides for positive regulation of the amount and rate of deposition of concrete in all dumping position, shall be employed.

1.6.21.7. In placing concrete in large open areas, the bucket shall be spotted directly over the position designated and then lowered for dumping. The open bucket shall clear the concrete already in place and the height of drop shall not exceed 1M. The bucket shall be opened slowly to avoid high vertical bounce. Dumping of buckets on the swing or in any manner which results in separation of ingredients or disturbance of previously placed concrete will not be permitted.

1.6.21.8. Concrete placed in restricted forms by wheel barrows, buggies, cars, short chutes or hand shovelling shall be subject to the requirement for vertical delivery of limited height to avoid segregation and shall be deposited as nearly as practicable in its final position.

1.6.21.9. Where it is necessary to use transfer chutes, specific approval of the Engineer-in-charge must be obtained to the type, length, slopes, baffles, vertical terminals and timing of operations, the discharge and without segregation. To allow for the loss of mortar against the sides of the chutes, the first mix shall have less coarse aggregate. During cleaning of chutes the waste water shall be kept clear of the forms. Concrete shall not be permitted to fall from the end of the chutes by more than 1 M. Chutes when approved for use shall have slopes not flatter than 1:2 chutes shall be of metal or metal

lined and of rounded cross section. The slopes of all chutes sections shall be approximately the same. The discharge end of the chutes shall be maintained above the surface of the concrete in the forms.

1.6.21.10. Concrete may be conveyed and placed by mechanically operated equipment e.g. pumps or pneumatic placers only with the written permission of the Engineer-in-charge. The slump shall be held to the minimum, necessary for conveying concrete by this method.

1.6.21.11. When pumping is adopted, before pumping of concrete is started, the pipeline shall be lubricated with one or two batches of mortar composed of one part cement and two parts sand. The concrete mix shall be specially designed to suit pumping. Care shall be taken to avoid stoppages in work once pumping has started.

1.6.21.12. When pneumatic placer is used, the manufacturer's advice on layout of pipeline shall be followed to avoid blockages and excessive wear. Restraint shall be provided at the discharge box to cater for the reaction at this end. Manufacturer's advice shall be followed regarding concrete quality and all other related matters when pumping or pneumatic placing equipment is used.

1.6.21.13. Concreting, once started, shall be continuous until the pour is completed. Concrete shall be placed in successive horizontal layers of uniform thickness ranging from 15 to 90 mm as directed by the Engineer-in-charge. These shall be placed as rapidly practicable to prevent the formation of cold joints or planes of weakness between each succeeding layer within the pour. The thickness of each layer shall be such that it can be deposited before the previous layer has stiffened. The bucket loads or other units of deposit shall be spotted progressively along the face of the layer with such overlap as well facilitate spreading the layer to uniform depth and texture with a minimum of shovelling. Any tendency to segregation shall be corrected by shovelling stones into mortar rather than mortar on to stones. Such a condition shall be corrected by redesign of mix or other means, as directed by the Engineer-in-charge.

1.6.21.11. The top surface of each pour and bedding planes shall be approximately horizontal unless otherwise instructed.

1.6.22. Compaction

1.6.22.1. The concrete shall be compacted during placing with approved vibrating equipment until the concrete has been consolidated to the maximum practicable density, is free of pockets of coarse aggregate and fits tightly against all form surfaces, reinforcement and embedded fixtures. Particular care shall be taken to ensure that all concrete placed against the forms' faces and into corners of forms or against hardened concrete at joints is free from voids or cavities. The use of vibrators shall be consistent with the concrete mix and caution exercised not to over-vibrate the concrete to the point that segregation results.

1.6.22.2. Vibrators shall conform to IS specifications. Type of vibrator to be used shall depend on the structure where concrete is to be placed. Shutter vibrators to be effective, shall be firmly secured to the formwork which must be sufficiently rigid to transmit the vibration and strong enough not to be damaged by it. Immersion vibrators

shall have no load frequency, amplitude and acceleration as per IS 2505 depending on the size of vibrator. Immersion vibrators in sufficient numbers and each of adequate size shall be used to properly consolidate all concrete. Tapping or external vibrating of forms by hand tools or immersion vibrators will not be permitted.

1.6.22.3. The exact manner of application and the most suitable machines for the purpose must be carefully considered and operated by experienced men. Immersion vibrators shall be inserted vertically at points not more than 450 mm apart and withdrawn when air bubbles cease to come to the surface. Immersion vibrators shall be withdrawn very slowly. In no case shall immersion vibrators be used to transport concrete inside the forms. Particular attention shall be paid to vibration at the top of a lift e.g. in a column or wall.

1.6.22.1. When placing concrete in layers, which are advancing horizontally as the work progresses, great care shall be exercised to ensure adequate vibration, blending and mixing of concrete between the succeeding layers.

1.6.22.5. The immersion vibrator shall penetrate the layer being placed and also penetrate the layer below when the under layer is still plastic to ensure good bond and homogeneity between the two layers and prevent the formation of cold joints.

1.6.22.6. Care shall be taken to prevent contact of immersion vibrators against reinforcement steel. Immersion vibrators shall not be allowed to come in contact with reinforcement steel after start of initial set. They shall also not be allowed to come in contact with forms or finished surfaces.

1.6.22.7. Form attached vibrators shall be used only with specific authorisation of the Engineer-in-charge.

1.6.22.8. The surface vibrators will not be permitted under normal conditions. However for thin slabs, vibration by specially designed vibrators may be permitted upon approval of the Engineer-in-charge.

1.6.22.9. The formation of stone pockets or mortar bondages in corner and against faces of forms shall not be permitted. Should these occur, they shall be dug out, reformed and refilled to sufficient depth and shape for through bonding, as directed by the Engineer-in-charge.

1.6.23. Placement interval

Except when placing with slip forms each placement of concrete in multiple lift work, shall be allowed to set for at least 24 hours after the final setting of concrete and before the start of a subsequent placement.

1.6.21. Special provision in placing

When placing concrete in walls with openings and in floors of integral slab and beam construction and other similar conditions, the placing shall stop when the concrete reaches the top of the opening in walls and bottom horizontal surface of the slab, as the

case may be. Placing shall be resumed before the concrete in place takes initial set, but not until it has time to settle as determined by the Engineer-in-charge.

1.6.25. Placing concrete through reinforcement steel

When placing of concrete through reinforced steel, care shall be taken to prevent segregation of the coarse aggregate. When the congestion of steel makes placing difficult it may be necessary to temporarily move the top steel aside to get proper placement and restore reinforcing steel to design position.

1.6.26. Bleeding

Bleeding of free water, on top of concrete being deposited, in to the forms shall be caused to stop the concrete pour. The conditions causing this defect corrected before any further concreting is resumed.

1.6.27. Curing, protecting, repairing and finishing

1.6.27.1. Curing

1.6.27.1.1. All concrete shall be cured by keeping it continuously damp for the period of time required for complete hydration and hardening to take place. Preference shall be given to the use of continuous sprays or ponded water continuously saturated covering of sacks, canvas, hessian, polythene sheets or other absorbent materials, or approved effective curing compounds applied with spraying equipment capable of producing a smooth, even textured coat. Extra precautions shall be exercised in curing concrete during cold and hot water as outlined hereinafter. The quality of curing water shall be the same as that used for mixing concrete.

1.6.27.1.2. Certain types of finish or preparation for overlaying concrete must be done at certain stage of the curing process and special treatment may be required for specific concrete surface finish.

1.6.27.1.3. Curing of concrete made of high alumina cement and super sulphated cement shall be carried out as directed by the Engineer-in-charge.

1.6.27.1.1. Fresh concrete shall be kept continuously wet for a minimum period of 15 days from the date of placing of concrete following a lapse of 12 to 14 hours after the laying of concrete. The curing of horizontal surfaces exposed to the drying winds shall however begin immediately the concrete has hardened. Water shall be applied uniformly to concrete surfaces within 1 hour after concrete has set. Water shall be applied to formed surfaces immediately upon removal of forms. Quantity of water applied shall be controlled so as to prevent erosion of freshly placed concrete.

1.6.27.1.5. Curing shall be assured by use of an ample water supply under pressure in pipes with all necessary appliance of hose, sprinklers and spraying devices. Continuous fine mist spraying or sprinkling shall be used, unless otherwise specified or approved by the Engineer-in-charge.

1.6.27.1.6. Whenever, by the judgement of the Engineer-in-charge, it may be necessary to omit the continuous spray method, a covering of clean sand or other approved means such as wet gunny bags which will prevent loss of moisture from the concrete, may be

used. No type of covering will be approved which would stain or damage the concrete during or after the curing period. Covering shall be kept continuously wet during the curing period.

1.6.27.1.7. For curing of concrete in pavements, side-walks floors, flat roofs or other level surfaces, the ponding method of curing is preferred. The method of containing the ponded water shall be approved by the Engineer-in-charge. Special attention shall be given to edges and corners of the slabs to ensure proper protection to these areas. The ponded area shall be kept continuously filled with water during the curing period.

1.6.27.1.8. Surface coating type compounds shall be used only on special permission of the Engineer-in-charge. Curing compounds shall be liquid type white pigmented. Other curing compounds shall be used on surfaces where future blending with concrete, water or acid proof membrane or painting is specified.

1.6.27.1.9. All equipment and materials required for curing shall be on hand and ready for use before concrete is placed.

1.6.28. Protecting fresh concrete

Fresh concrete shall be protected from defacements and damage due to construction operation by leaving forms in place for an ample period as specified later in these specifications. Newly placed concrete shall be protected by approved means such as tarpaulins from rain, sun and winds. Steps as approved by the Engineer-in-charge shall also be taken to protect immature concrete from damage by debris, excessive loading, vibration, abrasion or contact with other materials, etc., that may impair the strength and/or durability of the concrete. Workmen shall be warned against and prevented from disturbing green concrete during its setting period. If it is necessary that workmen enter the area of freshly placed concrete, the Engineer-in-charge may require that bridges be placed over the area.

1.6.29. Repair and replacement of unsatisfactory concrete

1.6.29.1. Immediately after the shuttering is removed, the surface of concrete shall be very carefully inspected and all defective areas called to the attention of the Engineer-in-charge who may permit patching of the defective areas or also reject the concrete unit either partially or entirely. Rejected concrete shall be removed and replaced by the Contractor at no additional expense to owner. Holes left by form bolts, etc., shall be filled up and made good with mortar composed of one part of cement to one and half parts of sand passing 2.36 mm IS sieve after removing any loose stones adhering to the concrete and shall be finished as described under the particular items of work.

1.6.29.2. Superficial honeycombed surfaces and rough patches shall be similarly made good immediately after removal of shuttering in the presence of the Engineer-in-charge and superficial water and air holes shall be filled in. The mortar shall be well worked into the surface with a wooden float. Excess water shall be avoided. Unless instructed otherwise by the Engineer the surface of the exposed concrete placed against shuttering shall be rubbed down immediately on removal of shuttering to remove fine or other

irregularities and necessary care being taken to avoid damage to the surface. Surface irregularities shall be removed by grinding.

1.6.29.3. If reinforcement is exposed or the honey combing occurs at vulnerable positions for example ends of beams or columns it may be necessary to cut out the member completely or in part and reconstruct the same. The decision of the Engineer-in-charge shall be final in this regard. If only patching is necessary, the defective concrete shall be cut out till solid concrete is reached (or to a minimum depth of 25 mm) the edges being cut perpendicular to the affected surface or with small undercut if possible. Anchors, tees or dovetail slots shall be provided whenever necessary to attach the new concrete securely in place an area extending several centimetres beyond the edges and the surfaces of the prepared voids shall be saturated with water for 24 hours immediately before the patching material is placed.

1.6.29.1. The use of epoxy for bonding fresh concrete used for repairs will be permitted upon written approval of Engineer-in-charge. Epoxy shall be applied in strict accordance with the instructions of the manufacturer.

1.6.29.5. Small size holes having surface dimensions about equal to the depth of the hole, holes left after removal of form bottom, grout insert holes and slots cut for repair of cracks shall be repaired as follows. The hole to be patched shall be roughened and thoroughly soaked with clean water until absorption stops.

1.6.29.6. A 5 mm thick layer of grout of equal parts of cement and sand shall be well brushed into the surface to be patched, followed immediately by the patching concrete which shall be well consolidated with a wooden float. The concrete patch shall be built up in 10 mm thick layers. After an hour or more, depending upon weather conditions, it shall be worked off flush with a wooden float and smooth finish obtained by wiping with hessian, a steel trowel shall be used for this purpose. The mix for patching shall be of same materials and in the same proportions as that used in the concrete being repaired, although some reduction in the maximum size of the coarse aggregates may be necessary and the mix shall be kept as dry as possible.

1.6.29.7. Mortar filling by air pressure (guniting) shall be used for repairing of areas too large and/or too shallow for patching with mortar. Patched surfaces shall be given a final treatment to match the colour and texture of the surrounding concrete. Cement shall be substituted for ordinary cement, if so directed by the Engineer-in-charge, to match the shade of the patch with original concrete.

1.6.29.8. The patched area shall be covered immediately with an approved non-staining water saturated material such as gunny bag which shall be kept continuously wet and protected against sun and wind for a period of 24 hours. Thereafter, the patched area shall be kept wet continuously by fine spray of sprinkling for not less than 10 days.

1.6.29.9. All materials, procedures and preparation used in the repairing of concrete and also the finished repair work shall be subject to the approval of the Engineer-in-charge. All fillings shall be tightly bonded to the concrete and shall be sound, free from shrinkage cracks after the fillings have been cured and finished.

1.6.30. Finishing

1.6.30.1. The type of finish for formed concrete surface shall be as follows, unless, otherwise specified by the Engineer-in-charge.

1.6.30.2. For surfaces against which backfill or concrete is to be placed, no treatment is required except repairing of defective area.

1.6.30.3. For surface below grade which will receive waterproofing treatment the concrete shall be free of surface irregularities which would interfere with proper application of the waterproofing material which is specified for use.

1.6.30.1. Unless specified, surfaces which will be exposed when the structure is in service shall receive no special finish, except repairing of damage or defective concrete removal of fins and abrupt irregularities, fillings of holes let by form ties and rods and clean up of loose or adhering debris.

1.6.30.5. Surfaces which will be exposed to the weather and which would normally be level, shall be sloped for drainage. Unless the drawing specifies such as stair treads, walls shall be sloped across the width approximately 1 in 30 broader surface such as walkways, roads, parking areas and platforms shall be sloped about 1 in 50. Surfaces that will be covered by backfill or concrete subfloors to be covered either concrete topping, terrazzo or quarry tile and similar surfaces shall be smoothly screeded and levelled to produce even surfaces. Surface irregularities shall not exceed 6 mm. Surfaces which will not be covered by backfill, concrete or tile toppings such as outside decks, floors of galleries and sumps, parapets, gutters, sidewall floors and slabs shall be consolidated, screeded and floated. Excess water and laitance shall be removed before finishing. Floating may be done with hand or power tools and started as the screeded surface has attained a stiffness to permit finishing operation and these shall be the minimum required to produce a surface uniform in texture and free from screed marks or other imperfections. Joints edges of panels and forms linings shall be of uniform size and be as large as practicable and installed with closed joints. Upon removal of forms, the joint marks shall be smoothed off and all blemishes, projections etc., removed leaving the surfaces reasonably smooth and unmarked.

1.6.31. Integral cement concrete finish

When specified on the drawings and integral cement concrete finish of specified thickness for floors and slabs shall be applied either monolithic or bonded as specified on the drawing as per IS2571. The surface shall be compacted and then floated with a wood float or power floating machine. The surface shall be tested with a straight edge and any high and low spots eliminated. Floating or trowelling of finish shall be permitted only after all surface water has evaporated. Dry cement or a mixture of dry cement and sand shall not be sprinkled directly on the surface of the cement finish to absorb moisture or to stiffen the mix.

1.6.32. Exposed Concrete finish/Rendering

A rubbed finish shall be provided only on exposed concrete surfaces as specified on the drawings. Upon removal of forms, all fins and other projections on the surfaces shall be

carefully removed, off-sets levelled and voids and damaged sections be immediately saturated with water and repaired by filling with a concrete or mortar of the same composition as was used in the surface. Then surface shall be thoroughly wetted and rubbed with carborundum or other abrasive. Cement mortar may be used in the rubbing, but the finished surface shall be brush coated with either cement grout after rubbing. The finished surfaces shall present a uniform and smooth appearance.

1.7. FORM WORK

The formwork shall consist of shores, bracings, sides of beams and columns, bottom of slabs, etc., including ties anchors, hangers inserts, etc., complete which shall be properly designed and planned for the work. False work shall be so constructed that necessary adjustment can be made to compensate for take up and settlements. Wedge may be used at the top or bottom of timber shores but not at both ends to facilitate vertical adjustment or dismantling of the formwork.

1.7.1. Design of formwork

The design of the formwork as well as its construction shall be the responsibility of Contractor. If so instructed, the drawings and/or calculation for the design for the formwork shall be submitted to the Engineer-in-charge for approval before proceeding with work, at no extra cost. The approval of the Engineer-in-charge shall not however relieve the Contractor of the full responsibility for the design and construction of the formwork. The design shall take into account all the load vertical and lateral that the forms will be carrying live and vibration loadings.

1.7.2. Type of formwork

Formwork may be of timber, plywood, metal, plastic or concrete. For special finishes the formwork may be lined with plywood, steel, sheets, oil, tempered hard board, etc. Sliding forms and slip forms may be used with the approval of the Engineer-in-charge.

1.7.3. Form work requirements

1.7.3.1. Forms shall conform to the shapes, lines, grades and dimensions including camber of the concrete as called for on the drawings. Ample studs, braces, ties, straps, etc., shall be used to hold the forms in proper position without any distortion whatsoever until the concrete is set sufficiently to permit removal of forms. Forms shall be strong enough to permit the use of immersion vibrators. In special cases form vibrators may also be used. The shuttering shall be close boarded. Timber shall be well seasoned, free from sap, shakes, loose knots, worm holes, warps or other surface defects in contact with concrete. Faces coming in contact with the concrete shall be free from adhering grout, plaster, paint, projecting nails, splits or other defects. Joints shall be sufficiently tight splits or other defects. Joints shall be sufficiently tight to prevent loss of water or any fine material from concrete.

1.7.3.2. Plywood shall be used for exposed concrete surfaces; where called for. Sawn and wrought timber may be used for unexposed surfaces. Inside faces of forms for concrete

surfaces which are to be rubbed finished shall be planed to remove irregularities or unevenness in the face. Formwork with linings shall be permitted.

1.7.3.3. All new and used form timber shall be maintained in a good condition with respect to shape, strength, rigidity, water tightness, smoothness and cleanliness of surfaces. Form timber unsatisfactory in any respect shall not be used and if rejected by the Engineer-in-charge shall be removed from the site.

1.7.3.1. Shores supporting successive members shall be placed directly over those below or be so designed and placed that the load will be transmitted directly to them. Trussed supports shall be provided for shores that cannot be secured on adequate foundations.

1.7.3.5. Formwork, during any stage of construction showing signs of distortion or distorted to such a degree that the intended concrete work will not conform to the exact contours indicated on the drawings, shall be repositioned and strengthened. Poured concrete affected by the faulty formwork, shall be removed completely and the formwork be corrected prior to placing of new concrete.

1.7.3.6. Excessive construction camber to compensate for shrinkage, settlement may impair the structural strength of members and shall not be permitted.

1.7.3.7. Forms shall be so designed that their removal will not damage the concrete. Face formwork shall provide true vertical and horizontal joints, conform to the architectural features of the structure as to location of joints and be as directed by the Engineer-in-charge.

1.7.3.8. Where exposed smooth or rendered concrete finishes are required the forms shall be constructed with special care so that the resulting concrete surfaces require a minimum finish.

1.7.1. Formwork for Slope Surfaces

1.7.1.1. Forms for sloped surfaces shall be built so that the formwork can be placed board-by-board immediately ahead of concrete placement so as to enable ready access for placement, vibration inspection and repair of the concrete.

1.7.1.2. The formwork shall also be built so that the boards can be removed one by one from the bottom up as soon as the concrete has attained sufficient stiffness to prevent sagging. Surfaces of construction joints and finished surfaces with slopes steeper than 4 horizontal: 1 vertical shall be formed as required herein.

1.7.5. Formwork for Curved Surfaces

1.7.5.1. The contractor shall interpolate intermediate sections as necessary and shall construct the forms so that the curvature will be continuous between sections. Where necessary to meet requirements for curvature, the form timber shall be built up of laminated splines cut to make tight, smooth form surfaces.

1.7.5.2. After the forms have been constructed, all surface imperfections shall be corrected and all surface irregularities at matching faces of form material shall be dressed to the specified curvature.

1.7.6. Formwork for Exposed Concrete Surfaces

1.7.6.1. Where it is desired, directed or shown on the drawings to have original fair face finish of concrete surface without any rendering or plastering, formwork shall be carried out by using wood planks, plywood or steel plates of approved quality and as per direction of the Engineer-in-charge.

1.7.6.2. The contractor shall use one type of material for all such exposed concrete faces and the forms shall be constructed so as to produce uniform and consistent texture and pattern on the face of the concrete. Patches or forms for these surfaces will not be permitted. The formwork shall be placed so that all horizontal formworks are continuous across the entire surface.

1.7.6.3. To achieve a finish which shall be free of board marks, the formwork shall be faced with plywood or equivalent material in large sheets. The sheets shall be arranged in an approved pattern. Wherever possible, joints between sheets shall be arranged to coincide with architectural features, sills, window heads or change in direction of the surface. All joints between shuttering plates or panels shall be vertical or horizontal unless otherwise directed. Suitable joints shall be provided between sheets. The joints shall be arranged and fitted so that no blemish or mark is imparted to the finished surfaces.

1.7.6.1. To achieve a finish which shall give the rough appearance of concrete cast against sawn boards, formwork boards unless otherwise stated shall be of 150 mm wide, securely jointed with tongued and grooved joints if required to prevent grout loss with tie rod positions and direction of boards carefully controlled. Sawn boards shall be set horizontally, vertically or at an inclination shown in the drawings. All bolt holes shall be accurately aligned horizontally and vertically and shall be filled with matching mortar recessed 5 mm back from the surrounding concrete face.

1.7.6.5. Forms for exposed concrete surfaces shall be constructed with grade strips (the underside of which indicated top of pour) at horizontal construction joints, unless the use of groove strips is specified on the drawings. Such forms shall be removed and reset from lift to lift, they shall not be continuous from lift to lift. Sheeting of reset forms shall be tightened against the concrete so that the forms will not be spread and permit irregularities or loss of mortar. Supplementary form ties shall be used as necessary to hold the reset forms tight against the concrete.

1.7.6.6. For fair faced concrete, the position of through bolts will be restricted and generally indicated on the drawings.

1.7.6.7. Chamfered strips shall be placed in the corners of forms for exposed exterior corners so as to produce 20 mm bevelled edges except where otherwise shown in the drawings. Interior corners and edges at formed joints shall not be bevelled unless shown on the drawings. Mouldings for grooves, drip courses and bands shall be made in the form itself.

1.7.6.8. The wood planks, plywood and steel plates used in formwork for obtaining exposed surfaces shall not be used for more than 3 times in case of wood planks, 6 times for plywood and 10 times for steel plates respectively. However, no forms will be allowed

for reuse, if in the opinion of the Engineer it is doubtful to produce desired texture of exposed concrete.

1.7.6.9. In order to obtain exposed concrete work of uniform colour it shall be necessary to ensure that the sand used for all exposed concrete work shall be of approved uniform colour. Moreover the cement used in the concrete for any complete element shall be from single consignment.

1.7.6.10. No exposed concrete surface shall be rendered or painted with cement or otherwise. Plastering of defective concrete as a means of achieving the required finish shall not be permitted, except in the case of minor porosity on the surface, where the Engineer-in-charge may allow a surface treatment by rubbing down with cement and sand mortar of the same richness and colour as for the concrete. This treatment shall be made immediately after removing the formwork.

1.7.6.11. The contractor shall also take all precautionary measures to prevent breaking and chipping of corners and edges of completed work until the building is handed over.

1.7.7. Bracings struts and props

1.7.7.1. Shuttering shall be braced, strutted, propped and so supported that it shall not deform under weight and pressure of the concrete and also due to the movement of men and other materials. **Bamboos shall not be used as props or cross bearers.**

1.7.7.2. The shuttering for beams and slabs shall be so erected that the shuttering on the sides of the beams and under the soffit of slabs can be removed without disturbing the beam bottoms. Re-propping of beams shall not be done except when props have to be reinstated to take care of construction loads anticipated to be in excess of the design load. Vertical props shall be supported on wedges or other measures shall be taken whereby the props can be generally lowered vertically while striking the shuttering. If the shuttering for a column is erected for the full height of the column, one side shall be left open and built up in sections as placing of concrete from the sides to limit the drop of concrete to 3metres or as directed by the Engineer-in-charge.

1.7.8. Mould Oil

1.7.8.1. Care shall be taken to see that the faces of form work coming in contact with concrete are perfectly cleaned and two coats of mould oil or any other approved material applied before fixing reinforcement and placing concrete. Such coating shall be insoluble in water, non-staining and not injurious to the concrete. It shall not become flaky or be removed by rain or wash water. Reinforcement and/or other items to be cast in the concrete shall not be placed until coating of the forms is complete and the adjoining concrete surface shall also be protected against contamination from the coating material.

1.7.9. Chamfers and fillets

1.7.9.1. All corners and angles exposed in the finished structure shall be formed with moulding to form chamfers or fillets on the finished concrete. The standard dimension of chamfers and fillers, unless otherwise specified shall be 20 mm x 20 mm. Care shall be

exercised to ensure accurate mouldings. The diagonal face of the mouldings shall be planned or surfaced to the same texture as the forms to which it is attached.

1.7.10. Wall ties

1.7.10.1. Wire ties passing through the walls shall not be allowed. In their place bolts through sleeves be used.

1.7.11. Reuse of forms

1.7.11.1. Before reuse, all forms shall be thoroughly scraped, cleaned, nails removed, holes that may leak suitably plugged and joints examined and when necessary, repaired and the inside retreated to prevent adhesion, to the satisfaction of the Engineer-in-charge. Warped timber shall be resized. Contractor shall equip himself with enough shuttering material to complete the job in the stipulated time.

1.7.12. Removal of forms

1.7.12.1. Contractor shall record on the drawings and in a special register the date upon which the concrete is placed in each part of the work and the date on which the shuttering is removed there from. The Contractor shall remove the shuttering after obtaining the approval of the Engineer-in-charge.

1.7.12.2. In no circumstances shall forms be struck until the concrete reaches strength of at least twice the stress due to self weight and any construction/erection loading to which the concrete may be subjected at the time of striking formwork.

1.7.12.3. In normal circumstances (generally where temperatures are above 20 Degree Centigrade) forms may be removed after expiry of the following periods:

	Ordinary Portland cement concrete	Rapid hardening Portland cement
Walls columns and vertical sides of beams	24 to 48 hrs as directed by the Engineer-in-charge	24 hrs.
Slabs proos left under	3 days	2 days
Beam soffits prods left under	7 days	4 days
Removal of props to slabs:		
Spanning up to 1.5m	7 days	4 days
Spanning over 1.5m.	14 days	8 days
Removal of props to		

beams & arches		
Spanning up to 6m	14 days	8 days
Spanning over 6m	21 days	12 days

1.7.12.1. Striking shall be done slowly with utmost care to avoid damage to arises and projections and without shock or vibration, by gently easing the wedges. If after removing the form work, it is found that timber has been embedded in the concrete, it shall be removed and made good as specified earlier.

1.7.12.5. Reinforced temporary openings shall be provided as directed by the Engineer-in-charge to facilitate removal of formwork which otherwise may be inaccessible.

1.7.12.6. Tie rods, clamps, form bolts etc., which must be entirely removed from walls or similar structures shall be loosened neither sooner than 24 hours nor later than 40 hrs after the concrete has been deposited. Ties, except those required to hold forms in place, may be removed at the same time. Ties, withdrawn from walls and grade beams shall be pulled towards the inside face cutting ties back from the faces of walls and grade beams will not be permitted.

1.7.12.7. For liquid retaining structures no sleeves for through bolts shall be used nor shall through bolts be removed as indicated above. The bolts, in this case, shall be cut at 25mm depth from the surface and then the hole shall be made good by sand, cement mortar of the same proportions as the concrete just after striking the formwork.

1.8. REINFORCEMENT STEEL

1.8.1. General

1.8.1.1. Reinforcement bars, if supplies are arranged by contractor, shall be either plain round mild steel bars grade I as per IS 432 (Part I) or medium tensile steel bar as per IS 432 (Part I) or hot rolled mild steel and medium tensile steel deformed bars as per IS 1139 or cold twisted steel bars as per IS1786, as shown and specified on the drawings. Wire mesh or fabric shall be in accordance with IS1566. Substitution of reinforcement will not be permitted except upon written approval from the Engineer-in-charge.

1.8.1.2. Plain round mild steel bars grade II as per IS 432 (Part I) may be used with prior approval of Engineer-in-charge in writing and with 10% increase in the reinforcement area but its use shall not be permitted in structures located in earthquake zones subjected to severe damage (as per IS 1895) and for structures subject to dynamic loading (other than wind loading), such as frames supporting rotary or reciprocating machinery, etc.

1.8.1.3. All reinforcement shall be clean, free from grease, oil, paint, loose mill scale, loose rust, dust, bituminous material or any other substances that will destroy or reduce the bond. All rods shall be thoroughly cleaned before being fabricated. Pitted and defective rods shall not be used.

1.8.2. All concrete in the works shall be of design mix as defined in IS 456, unless it is a nominal mix concrete such as 1:3:6, 1:4:8 or 1:5:10. Whether reinforced or otherwise, all design mix concrete works to be carried out under this specification shall be divided into the following classifications:

1.8.3. Providing, fabricating and placing in position reinforcement steel

1.8.3.1. The quality of the steel shall be as mentioned in the materials section. The bars shall be fabricated as per the drawings. Laps and splices for reinforcement shall be as shown on the drawings. Splices in adjacent bars shall be approved by the Engineer-in-charge. The bars shall not be lapped unless the length required exceeds the maximum available lengths of bars at site.

1.8.1. Bending

1.8.1.1. Reinforcing bars supplied bent or in coils, shall be straightened before they are cut to size. Straightening of bars shall be done in cold and without damaging the bars. This is considered as a part of reinforcement binding fabricating work.

1.8.1.2**.** All bars shall be accurately bent according to the sizes and shapes shown on the detailed working drawings/bar bending schedules. They shall be bent gradually by machine or other approved means. Reinforcing bars shall not be straightened and re-bent in a manner that will injure the material, bars containing cracks or splits shall be rejected. They shall be bent cold, except bars of over 32 mm in diameter which may be bent hot if specifically approved by the Engineer-in-charge. Bars bent hot shall not be heated beyond cherry red colour (not exceeding 845oC) and after bending shall be allowed to cool slowly without quenching. Bars incorrectly bent shall be used only if the means used for straightening and re-bending shall not injure the material. No reinforcement shall be bent when in position in the work without approval whether or not it is partially embedded in hardened concrete. **Bars having kind of bends other than those required by design shall not be used.**

1.8.5. Fixing

Reinforcement shall be accurately fixed by any approved means and maintained in the correct position shown in the drawings by the use of block, spacers and chairs as per **IS2502** to prevent displacement during placing and compaction of concrete. Bars intended to be in contact at crossing points shall be strongly bound together at all such points with two no.16 gauge annealed soft iron wire. The vertical distance required between successive layers of bar in beams or other members shall be maintained by providing of mild steel spacer bars at such intervals that the main bars do not perceptibly sag **between adjacent spacer bars.**

1.8.6. Cover

1.8.6.1. Unless indicated otherwise on the drawings, clear concrete cover for reinforcement (exclusive of plaster or other decorative finish) shall be as follows:

i. At each end of reinforcing bar, not less than 25 mm nor less than twice the diameter of the bar whichever is less.

ii. For a longitudinal reinforcing bar in a column, not less than 40 mm, nor less than the diameter of the bar. In case of columns of minimum dimensions of 20 cm or under, with reinforcing bars of 12 mm and less in diameter, a cover of 25 mm may be used.

iii. For longitudinal reinforcing bars in a beam, 25 mm nor less than the diameter of the bar.

iv. For tensile, compressive, shear, or other reinforcement in a slab or wall not less than 12 mm or less than the diameter of such reinforcement.

v. For any other reinforcement not less than 12 mm nor less than the diameter of such reinforcement.

1.8.6.2. For footings and other principal structural members in which the concrete is deposited directly against the ground, cover to the bottom reinforcement shall be 75 mm. If concrete is poured on a layer of lean concrete the bottom cover may be reduced to 50 mm.

1.8.6.3. For concrete surfaces exposed to the weather or the ground after removal of forms, such as retaining walls, footing sides and top, etc., not less than 50 mm for bars larger than 16 mm diameter and not less than 40 mm for bars 16 mm diameter or smaller

1.8.6.1. Increased cover thickness shall be provided, as indicated on the drawings, for surfaces exposed to the action of harmful chemicals (or exposed to earth contaminated by such chemical, acid, alkali, saline atmosphere, sulphurous smoke, etc.

1.8.6.5. For reinforced concrete members, totally or periodically immersed in sea water or subject to sea water spray, the cover of concrete shall be 50 mm more than those specified in (i) to (v) above.

1.8.6.6. For liquid retaining structures the minimum cover to all steel shall be 40 mm or the diameter of the main bars, whichever is greater. In the presence of sea water and soils and waters of a corrosive character the cover shall be increased by 10 mm.

1.8.6.7. Protection to reinforcement in case of concrete exposed to harmful surroundings may also be given by providing a dense impermeable concrete with approved protective coatings, as specified by the Engineer-in-charge.

1.8.6.8. The correct cover shall be maintained by cement mortar cover blocks. Reinforcement for footings, beams and slabs on sub-grade shall be supported on precast concrete blocks as approved by Engineer-in-charge. The use of pebbles or stones shall not be permitted.

1.8.7. Pre-cast slabs and Boundary blocks

Casting of pre-cast slabs and boundary blocks etc. shall be carried at the central casting yards which are to be erected by the Contractor to his convenience and curing shall be done by flooding water for minimum of 15 days. The drawing of the paving slabs illustrates typical dimensions of slab. The cover slab is proposed for the drains only for the width of the road at the entry to the plots. The kerbs formed along the cable trenches and dividers are to be of perfect shape and straight with the expansion joints

etc. For casting of paving slab perfect machined steel shuttering as per actual dimensions and right angles should be used. The edges of the slabs shall be perfect square with no honey combing. The finish of the slabs for all sides has to be obtained simultaneous to concreting and no patching or plastering shall be allowed. The slabs of any buckling or defects shall be rejected. The surfaces stone wash finish of the pre-cast slabs have to be done simultaneously with casting of the slab. We expect perfect finish for the surface with the stone surface exposed by the stones strongly and adhering to the base. The sealing notch in the side wall of duct has to be perfectly made so that the slab when placed shall have a perfect seating and an even level surface. No cement mortar levelling shall be allowed. Conveying of slabs has to be done carefully without any damage to sides/corners.

1.8.8. Inspection

Erected and secured reinforcement shall be inspected, jointly measured and recorded and approved by the Engineer-in-charge prior to the placement of concrete.

1.9. MASONRY WORKS

1.9.1. Applicable codes and specifications

1.9.1.1. The following codes, standards and specifications are made a part of this specification. All standards, tentative specifications, codes of practices referred to herein shall be the latest edition including all applicable official amendments and revisions.

IS1077 - Common burnt clay building bricks
IS3102 - Classification of burnt clay bricks
IS2180 - Burnt clay building bricks, heavy duty
IS3495 - Method of sampling and testing clay building bricks
IS2691 - Burnt clay facing bricks
IS2221 - Code of practice for brick work
IS2185 - Load bearing hollow concrete blocks
IS5498 - Lime-cement-cinder hollow concrete blocks
IS3115 - Lime-cement cinder solid blocks
IS1597 - Code of practice for construction of stone masonry (Part I)

1.9.2. Brick

1.9.3. Bricks used in works shall be bricks of specified crushing strength as described in the Schedule of Quantities. They shall have the following general properties:

1.9.1. They shall be sound, hard and homogenous in texture, well burnt in kiln without being verified, table moulded, deep red, cherry or copper coloured, of regular shape and size and shall have sharp and square edges and paralleled faces. The bricks shall be free from pores, chips, flaws or humps of any kind. Bricks containing ungrounded particles and which absorb water more than 1/5th of their weight when soaked in water for twenty

four hours shall be rejected. Over burnt or under burnt bricks shall be liable to rejection. These bricks shall give a clear ringing sound when struck.

1.9.5. Samples of bricks shall be submitted to the Engineer-in-charge for approval, before starting the brickwork. Bricks supplied shall conform to these approved samples. Brick samples shall be got tested as per IS3495 by the Contractor at no extra cost. Bricks rejected by the Engineer-in-charge shall be removed from the site of works within 24 hours.

1.9.6. Mortar

1.9.6.1. Mix for cement mortar shall be as specified in the respective items of work. Gauge boxes for sand shall be of such dimensions that one complete bag of cement containing 50 kg of cement forms one unit. The sand shall be free from clay, shale, loam, alkali, and organic matter and made of sound, hard, clean and durable practices. Sand shall be approved by the Engineer-in-charge. If so directed by the Engineer-in-charge, sand shall be thoroughly washed till it is free of any contamination.

1.9.6.2. For preparing cement mortar the ingredients shall first be mixed thoroughly in dry condition. Water shall then be added and mixing continued to give a uniform mix of required consistency. Cement mortar shall preferably be machine mixed, through mixing in a thorough manner may be allowed. The mortar so mixed shall be used within 30 minutes of mixing. Mortar left unused in the specified period shall be rejected.

1.9.6.3. The Contractor shall arrange for test on mortar samples if so directed by the Engineer-in-charge re-tempering of mortar shall not be permitted.

1.9.7. Workmanship

1.9.7.1. All bricks shall be thoroughly soaked in clean water for at least one hour immediately before being laid. The cement mortar for brick masonry work shall be as specified in the respective item of work. **Brick work 230 mm thick and over shall be laid in English bond unless otherwise specified**. While laying bricks shall be pressed into the mortar and shoved into final position so as to embed the brick fully in mortar. Bricks shall be laid with frogs uppermost.

1.9.7.2. All brick work shall be plumb, square and true to dimensions. Vertical joints in alternate courses shall come directly one over the other and be in line. Horizontal courses shall be levelled. The thickness of brick courses shall be kept uniform. For walls of thickness greater than 230 mm both faces shall be kept in vertical planes. No broken bricks shall be used except as closers. Care shall be taken that the bricks forming the top corners and ends of the wall shall be properly radiated and keyed into position. Holes kept in masonry for scaffolding shall be closed before plastering. All interconnected brickwork shall be carried out at nearly one level (so that there is uniform distribution of pressure on the supporting structure) and no portion of the work shall be left more than one course lower than the adjacent work where this is not possible, the work shall be raked back accordingly to bond (and not saw toothed) at an angle not exceeding 45o.

1.9.7.3. Bricks shall be so laid that all joints are well filled with mortar. The thickness of joints shall not be less than 6 mm and not more than 10 mm. The face joint shall be raked to a minimum depth of 12 mm by raking tools daily during the progress of work

when the mortar is still green so as to provide a proper key for the plaster or pointing to be done. Where plastering or pointing is not required to be done the joints shall be uniform in thickness and be struck flush and finished at the time of laying. The face of brickwork shall be cleaned daily and all mortar droppings removed. The surface of each course shall be thoroughly cleaned of all dirt before another course is laid on top. If the mortar in the lower course has begun to set the joints shall be raked out to depth of 12 mm before another course is laid.

1.9.7.1. All brick work shall be built tightly against columns, floor slabs or other structural member.

1.9.7.5. Where drawings indicate that structural steel columns are to be fireproofed with brick work, the brick shall be built closely against all flanges and webs with all spaces between the steel and bricks works filled solid with mortar. Steel members partly embedded in brickwork and not indicated to be fireproofed with concrete shall be covered with not less than 12 mm thick mortar unless directed otherwise by Engineer-in-charge.

1.9.7.6. The work shall be cured for 15 days.

1.9.8. Miscellaneous inserts in masonry for example sleeves, wall ties, anchors, conduits, structural sheet, steel lintels, etc., shall be installed by the Contractor**. Furnishing fixing of any of these inserts by the Contractor will be paid for separately under steel work**. Openings, arches, etc., shall be provided as shown on the drawings, chasses, pockets, etc., shall be provided as shown on the drawings to receive rain water pipes, etc. Wall ties and flashings shall be built into the brickwork in accordance with the drawings and specifications.

1.10. RUBBLE MASONRY

1.10.1. Stones for this work shall be hard, durable rock, close or fine grained and uniform in colour free from veins, flaws and other defects and shall conform to IS1597 (Part I). The stones shall be laid in mortar proportions specified for the particular item of work. Stones shall be got approved.

1.10.2. For all work below ground level the masonry shall be uncoursed random rubble with ordinary quarry dressed stones or hearting and faced with selected quarry dressed stones.

1.10.3. For all work above ground level the masonry shall be random rubble faced with hammer dressed stones with squared quoins at joints and corners.

1.10.1. No stones shall tail into the wall, either with a point or to length less than 11-2 times its height. The thickness of the joints shall not exceed 12 mm.

1.10.5. Spauls and pinnings shall not be allowed to show on the face of the wall. Two bond stones each of minimum area of 500 sq cm for every 1.0 sq m of each wall face shall be provided. These shall be through stones in walls 600 mm thick and under, in walls thicker than 600 mm the length of bond stones shall be 2/3 times the thickness of walls. The stones for hearting of the wall shall not be less than 150 mm in any direction. Chips and spauls shall be wedged in to avoid thick mortar beds and joints. The wall faces,

corners and joints or openings shall be truly vertical the quoins shall be of selected stones, neatly dressed with chisel to form the required angle and laid header and stretcher alternatively.

1.10.6. The exposed face of the work shall be carefully and neatly pointed with mortar in all joints on the other side the joints shall be neatly struck with trowel while the mortar is fresh.

1.10.7. Mortar

1.10.7.1. The mortar for the work shall be as specified in the respective item of work. Curing of masonry shall continue for a minimum of ten days.

1.11. SOLID CONCRETE BLOCK MASONRY - Conforming to IS 2185 (Part 1): 2005

The solid concrete blocks are used as load bearing units and shall have a block density not less than 1800 kg/m3.

Physical Requirements

1.11.1 ***General***

1.11.1.1 All units shall be sound and free of cracks or other defects which interfere with the proper placing of the unit or impair the strength or performance of the construction. Minor chipping resulting from the customary methods of handling during delivery, shall not be deemed grounds for rejection.

1.11.1.2 Where units are to be used in exposed wall construction, the face or faces that are to be exposed shall be free of chips, cracks, or other imperfections, except that if not more than 5 percent of a consignment contains slight cracks or small chippings not larger than 25 mm, this shall not be deemed grounds for rejection.

1.11.2 ***Dimensions***

The overall dimensions of the units when measured shall be in accordance with as given in IS 2185 (Part 1): 2005 Annex B subject to the tolerances mentioned therein.

1.11.3 ***Block Density***

The block density when determined shall conform to the requirement as given in IS 2185 (Part 1): 2005 Annex C.

1.11.4 ***Compressive Strength***

The minimum compressive strength at 28 days being the average of eight units, and the minimum compressive strength at 28 days of individual units, when tested in the manner described in IS 2185 (Part 1): 2005 Annex D shall be as prescribed in Table below.

Type	*Grade*	*Density of Block*	*Minimum Average Compressive Strength of Units*	*Minimum Compressive Strength of Individual Units,*
		kg/m2	*N/mm²*	*N/mm²*
Hollow (open and closed cavity) load bearing unit	A(3.5)	Not less than 1500	3.5	2.8
	A(1.5)		1.5	3.6
	A(5.5)		5.5	1.4
	A(7.0)		7.0	5.6
	A(8.5)		8.5	7.0
	A(10.0)		10.0	8.0
	A(12.5)		12.5	10.0
	A(15.0)		15.0	12.0
	B(3.5)	Less than 1500 but not less than 1 100	3.5	2.8
	B(5.0)		5.0	1.0
Solid load bearing unit	C(5.0)	Not less than 1800	5.0	1.0
	C(1.0)		1.0	3.2

1.11.5 ***Water Absorption***

The water absorption, being the average of three units, when determined in the manner prescribed in IS 2185 (Part 1): 2005 Annex E shall not be more than 10 percent by mass.

1.11.6 ***Drying Shrinkage***

The drying shrinkage of the units when unrestrained being the average of three units, shall be determined in the manner described in IS 2185 (Part 1): 2005 Annex F and shall not exceed 0.06 percent.

1.11.7 ***Moisture Movement***

The moisture movement of the dried blocks on immersion in water, being the average of three units, when determined in the manner described in IS 2185 (Part 1): 2005 Annex G, shall not exceed 0.09 percent

1.12. INTERLOCKING PAVER LAYING WORKS

1.12.1 ***Surface to receive Tiles***

Tiling shall be carried out on completed WMM or well compacted sub base as per the particular requirement set for the project.

1.12.2 ***Laying of Heavy duty paver tiles***

The Heavy duty paver tiles shall be laid over a bedding sand layer of specified thickness conforming to the grading as specified in IRC SP 63:2004 and shown below. Average thickness of laying course shall be 20-40mm and the moisture content shall be 4% by weight.

IS Sieve Size	**% by weight passing**
9.52mm	100
1.75mm	95-100
2.36mm	80-100
1.18mm	50-95
600 microns	25-60
300 microns	10-30
150 microns	0-15
75 microns	0-10

The material shall be free from clay, silt and deleterious matter. The bedding layer shall be checked for profile correctness. Walking and driving over the bedding layer shall not be permitted. Joint filler shall be of following grade requirement. Cement shall not be used.

IS Sieve Size	**% by weight passing**
2.36mm	100
1.18mm	90-100
600 microns	60-90
300 microns	30-60
150 microns	15-30
75 microns	0-10

A. Frequency of testing

At least one week prior to commencement of the work, the Contractor shall draw up a Quality Assurance Plan (QAP) and documentation for all aspects of the work and submit for review. Contractor shall establish a lab for the entire above test to be done at site.

B. Test for materials

i. *Coarse aggregates*

1. Before the commencement of the works, at least 3 samples in accordance with the procedure laid down in IS:2430 shall be taken for each quarry source to ascertain the quality, suitability and fitness of the available material for use in the works. Fresh test shall be conducted, in case there is any change in the source or the type of rock being quarried. The proposal, along with a copy of test reports, shall be submitted to the Engineer for review and comments, if any.

2. Aggregate having more than 0.5% of sulphate as SO_3 with water absorption more than 2% of its own weight shall not be used.

3. In case of doubt, the alkali-aggregate reactivity shall be tested in accordance with IS:2386 (Part 6). Coarse aggregates having positive alkali-silica reaction (ASR) shall not be used.

4. The maximum value of flakiness index for coarse aggregates shall not exceed 35%.

ii. *Sand /Fine aggregates*

1. All fine aggregates shall confirm to IS: 383 and test for conformity shall be carried out as per IS:2386 (Part I to VIII). The fineness modulus of fine aggregates shall be between 2 and 3.5.

2. Before the commencement of the works, at least 3 samples as per IS: 2430 shall be taken for each quarry source, to ascertain the quality, suitability and fitness of the available materials for use in the works and the proposal along with a copy of test reports shall be submitted to the Engineer for review and comments, if any.

3. Fine aggregates having positive alkali-silica reaction shall not be used.

iii. *Water*

1. Water for use in the works for mixing and curing shall be in conformity with Clause 302.4 of IRD:21.

2. Water for each source shall be tested before the start of works and thereafter every 3 months and after each monsoon, till the completion of the works and proposal along with a copy of test reports shall be submitted to the Engineer for review and comments, if any.

C. ***Test for paver tiles***

Source of materials shall be got approved prior to commencement of work. Size tolerance shall be randomly checked as per IS 15658 : 2006. Each lot shall be subjected to test for ascertaining the crushing strength and water absorption properties.

Finished level of pavements shall have a tolerance of not more than 10mm.

The surface finish and quality of materials and works shall conform to the requirements of Clauses 902 and 903 of MoRTH Specifications. Engineer has the authority to ask for further tests if required.

1.13. WOODWORK

1.13.1. Applicable Codes

1) IS4021 - Timber door, window and ventilator frames
2) IS2202 - Wooden flush door shutters (solid core type) Part I
3) IS1003 - Timber panelled and glazed shutters (Part I & II)
4) IS4020 - Method of tests for wooden flush doors: Type tests
5) IS1761 - Transparent sheet glass for glazing and framing purposes
6) IS3097 - Specification for veneered particle boards (Exterior Grade)

1.13.2. General

1.13.2.1. Wood used for all work shall be the best of the respective class specified, and properly seasoned, suitable for joinery work should be of natural growth, uniform in texture, straight grained, free from sapwood, dead knots, open shakes, rot, decay and any other defects and blemishes.

1.13.2.2. For joints following principles to be observed:

i. At the joints the weakness of the pieces must be minimum as far as possible, to place each abutting surface in a joint as neatly as possible, perpendicular to pressure and to form and fit accurately every pair of surface that may come in contact.

ii. All joining shall be wrought on all faces and finished off by hand with sand paper with slightly rounded arises.

iii. The joints shall be pinned with hard wood pins and put together with white lead. Jointing shall be by means of mortice and tenon or dovetailed joints as approved. For external work the joints shall be coated with white or red lead before the members are put together. For internal joints where there is no chance of moisture the joint shall be glued. Driving of screws with hammer is prohibited. The screws shall be soaked in oil before driving them home. The heads of the screws and nails shall be sunk and puttied.

iv. Any joinery work which shall split, fracture, shrink or show flaws or other defects due to unsoundness, inadequate seasoning or bad workmanship, shall be removed and replaced with sound materials at the Contractor's expense.

v. Door frames shall be rebated. All dimensions shall be as per drawings. The verticals of door frames shall project about 50 mm below finished floor, surface coming in contact with brick work shall be painted with bitumen or solignum as directed by the Engineer-in-charge. The door frame shall be provided with 3 nos. MS 230x30x3 mm flat split hold fasts on each side, respectively. These hold fasts shall be embedded in masonry or concrete work with concrete block of mix 12:2:4 and size 230x300x250. The work shall conform to IS4021.

vi. The door shall be panelled or solid flush doors or as described in the item of work. All doors shall be supplied with approved fittings such as hinges, mortice lock of approved make with handles on both the sides, oxidised brass tower bolts and latch arrangements, door stops, etc., and as shown in drawings. External flush doors shall be made of weatherproof plywood as per Item Description in the Schedule of Quantities.

vii. The workmanship of all doors and window shutters shall conform to the requirements of IS1003 (Parts I & II) and IS2202 (Part I). Flush door panels shall be got tested as per IS4020 in Standard Laboratories.

viii. Beading and architraves shall conform to the shapes shown on drawings or as approved and fixed by means of screws (counter sunk or otherwise) or bolts.

1.11. GLASS

1.11.1. Sheet glass or plate glass shall be of Indian make as specified in the Schedule of Quantities/as directed. It shall be free from waves and bubbles and all defects. The thickness of the glass shall be as follows:
2 mm thick glass for panes up to 900 sq.cm. area
3 mm thick glass for panes from 900 - 5500 sq.cm. area
4 mm thick glass for panes 5500 - 8400 sq.cm. area
5.5 mm thick glass or plate glass for panes above 8400 sq.cm.
1.11.2. It should be clearly understood that glass which does not have uniform refractive index or which is wavy, will be rejected. The glazing shall be fixed with teak wood beading and putty.

1.11.3. It shall conform to IS1761. The putty shall be made up of one part of white lead, 3 parts of finely powdered chalk and adding boiled linseed oil to make a stiff elastic paste. No voids shall be left in the putty. Woodwork shall not be painted, oiled or otherwise treated before it has been approved by the Engineer-in-charge.

1.11.1. The window frame shall be provided with 2 nos. MS 230x30x3 mm flat split hold fasts on each side, respectively. These hold fasts shall be embedded in masonry or concrete work with concrete block of mix 1:2:4 and size 230x300x250 mm.

1.11.5. The type of windows shall be as specified. Each leaf of the shutter shall have one pair of hinges for a width of less than or equal to 2 feet, for width more than 2 feet extra nos. of hinges shall be provided as directed by the Engineer-in-charge at no extra cost. The glazed windows shall be provided with glass of thickness as specified in the Item Description. Architraves shall be provided as per drawing.

1.15. FINISHING WORKS

1.15.1. **Applicable Codes**

1) IS2394 - Code of practice for application of lime plaster finish
2) IS1477 - Code of practice for painting of ferrous metals in buildings and allied finishes (Part I & II)

3) IS427 - Distemper, dry colour as required
4) IS2395 - Code of practice for painting concrete, masonry and plaster surfaces
5) IS428 - Distemper, oil emulsion, colour

1.16. PLASTERING

1.16.1. The surface to be plastered shall be washed with fresh clean water free from all dirt, loose material grease, etc., and thoroughly wetted for 6 hours before plastering work is commenced. Concrete surfaces to be plastered will however be kept dry. The wall should not be too wet but only damp at the time of plastering. The damping shall be uniform to get uniform bond between the plaster and the wall. The junction between the brick work and RCC should be fixed with chicken wire mesh/PVC strip as directed before plastering.

1.16.2. The proportion of the mortar shall be as specified under the respective items of work. Cement shall be mixed thoroughly in dry condition and then just enough water added to obtain a workable consistency. The quality of water, sand and cement shall be as mentioned in the Specifications for Concrete & Allied works. The mortar thus mixed shall be used immediately and in no case shall the mortar be allowed to stand for more than 30 minutes after mixing with water. The plaster shall be laid in a single coat. The mortar shall be splashed on the prepared surface with a trowel and finished smooth by trowelling. The plastered surface shall be rubbed with iron plate till the surface shows cement paste. The work shall be in line and level. Curing of plaster shall be started as soon as the applied plaster has hardened enough so as not to be damaged. Curing shall be done by continuously applying water in a fine spray and shall be carried out for at least 7 days.

1.16.3. The plaster shall be carried out on jambs, lintel and sill faces top and undersides, etc., as shown in the drawing or as directed by the Engineer-in-charge.

1.16.1. Providing & Applying Cement paint

This may be "SNOWCEM" or of equivalent make. The surface shall be prepared as specified in the specification for white wash. This shall be applied with brush on the plastered wall. The strokes shall be even and it shall be cured at least for 7 days. No patch or brush stroke shall be seen. Three coats shall be applied.

1.17. PROVIDING & FIXING CHICKEN WIRE MESH

1.17.1. The wire mesh shall be of 24gauge and it shall be fixed with nails at the junction of brick masonry and RCC elements. The chicken wire mesh shall not sag in between the nails. This shall be done before the application of plaster.

1.18. FLOORING

1.18.1. **Applicable codes**

1) IS1443 - Code of practice for laying and finishing of cement concrete flooring tiles.

2) IS2114 - Code of practice for laying in situ terrazzo floor finish
3) IS 777 - Glazed earthenware tiles

1.18.2. **Providing & Laying Ceramic tiles in flooring, skirting and dado**

1.18.3. The ceramic tiles in flooring and dado shall be of first class quality as specified in the Item Specification and shall be approved by the Engineer-in-charge. The tiles shall be of standard size without warp and with straight edges, true and even in shape and size and of uniform colour. The tiles surface shall be of fine grained texture, dense and homogeneous. The thickness of the tile shall be as per the Item Specification. The tiles shall be submerged in water till the bubbles cease.

1.18.1. They should be laid on a base of 12 mm thick mortar bed (cement or lime 1:3 sand) and cement (3 kg/sqm) paste. They shall be laid truly vertical on walls and truly horizontal on floors or to slopes as directed. The joint shall be very thin, uniform and perfectly straight. The tiles in dado shall be finished in such a way that, only the tile thickness projects over the finished plaster or as specified otherwise. Where full tiles are not possible, the same should be cut or sawn to the required size and their edge rubbed to ensure straight and true joints. After the tiles are laid extra cement grout shall be removed. The joints shall be cleaned with wire brush and then the joint shall be floated with white or gray cement as approved by the Engineer-in-charge. The tiles shall be cleaned after the work is complete.

1.19. STEEL WORK

1.19.1. **Providing and fixing steel doors/windows/ventilators**

1.19.1.1. The steel doors, windows, ventilators shall conform to IS7452 and IS1036. All steel doors, windows, ventilators, louvres, etc. shall be of sizes as specified and conform to the description in the respective items of work. Whether or not specifically mentioned, all fixtures and fittings necessary for the satisfactory operation of the doors and windows shall be provided. Doors, windows and ventilators shall be obtained from an approved manufacturer. Specific approval for such purchase shall be obtained beforehand. The sample shall also be got approved before further manufacturing starts, unless this is waived in writing by the Engineer-in-charge. All steel doors shall be of pressed steel (18 gauge) flush type with or without removable transom. All doors shall be provided with a three way bolting device and locking arrangement with duplicate keys and handles on both sides and operable from either side. The Contractor shall obtain windows with friction hinges in place of windows with peg stays if so directed by the Engineer-in-charge. For centre hung and top hung ventilators suitable spring catch/pulley and chord arrangement shall be provided for facility of opening. Whenever fly meshes over windows have been called for, they shall be fixed on the window and suitable lever type or rototype arrangement shall be provided for opening or closing of the glazed panels from inside. Prior the approval of the Engineer-in-charge shall be taken before order is placed with the manufacturer.

1.19.1.2. Where specified, steel door supplied shall be airtight. For this purpose, the Contractor shall provide necessary padding material such as rubber, felt or any other approved material.

1.19.1.3. The rate quoted shall be inclusive of glazing with 4mm thick glass free from all blemishes. The workmanship shall conform to IS1081. The rate quoted shall also be inclusive of fixing doors, windows, ventilators, louvres, etc. in brick work, steel framing, etc. by making holes/drilling holes in steel work where required complete.

1.19.1.1. The rate shall also include cost of painting two coats of approved enamel paint over two coat of approved zinc chromate primer.

1.19.2. Providing and fixing inserts in concrete works

1.19.2.1. Inserts are required to be fixed/embedded as indicated in construction drawings and/or as directed by Engineer- in-charge in foundations, columns and other miscellaneous concrete works. These inserts comprise plates, angles, pipe sleeves, anchor bolt assemblies, etc.

1.19.2.2. The rate quoted by the Tenderer shall hold good for accurately fixing the inserts at the correct levels/alignment and shall include for the cost of any temporary or permanent supports/anchors such as bars including cutting, bending, welding, etc. as required.

1.19.2.3. Steel templates shall be used by Contractor to locate and very accurately position bolts, group of bolts, inserts, embedded parts, etc. at his cost. Such templates shall be previously approved by the Engineer-in-charge. Templates shall invariably be supported such that the same is not disturbed due to vibration, movement of labourers, materials, shuttering work, reinforcement, etc. while concreting. The Contractor will have to suitably bend, cut or otherwise adjust the reinforcement in concrete at the locations of inserts as directed by the Engineer-in-charge at no extra cost to OWNER. If the Engineer-in-charge so directs, the inserts will have to be welded to reinforcement to keep them in place. Contractor shall be responsible for the accuracy of dimensions, levels, alignments and centre lines of the inserts in accordance with the drawings and for maintenance of the same until the erection of equipment/structure or final acceptance by Owner.

1.19.2.1. Contractor shall ensure proper protection of all bolts, inserts, etc. from weather and other damages by greasing or other approved means such as applying white lead putty and wrapping them with gunny bags or canvas or by other means as directed by the Engineer-in-charge to avoid damage due to movement of his labourers, material, equipment, etc. No extra claim from the Contractor on this account shall be entertained. Contractor shall be solely responsible for all the damages caused to bolts, inserts, etc. due to his negligence and in case damages do occur, they shall be rectified to the satisfaction of the Engineer –in-charge at the Contractor's cost.

1.19.3. Providing and fixing in position grill, railing, steel ladder, etc.

This work shall be carried out as per the detailed drawings. The MS sections shall be of approved quality. The welding shall be perfect and the junctions shall be ground

properly. The frames shall be provided with hold fasts and the same shall be grouted with CC blocks in brick work. It shall be painted with two coats of zinc chromate primer and two coats of synthetic enamel paint of approved make and colour.

1.20. ROOFING

1.20.1. Providing, Fabricating & Erecting MS Structural steel work for trusses, purlins, girders, columns, rafters, struts, wind ties, bracings, etc.

1.20.2. All structural steel materials such as angles, RS joists, flats, tees, plates, channels, etc., shall conform to the latest edition of IS226. All structural steel shall be free from twist before fabrication. Cutting of members shall be done by shearing, cropping, sawing or gas cutting. Contact surfaces of plates and butt joints shall be accurately machined over the whole area so that the parts connected shall butt over the entire surface of contact. Welding of pieces shall be done with the approval of the Engineer-in-charge.

1.20.3. The components parts shall be assembled in such a manner that they are not damaged in any way and specific cambers as shown in the drawing or as directed by the Engineer-in-charge, shall be provided.

1.20.1. For bolted connection, where necessary washers shall be tapered or otherwise suitably shaped to give satisfactory bearing. The threaded portion of the bolt shall project beyond the nut by at least 1.5 thread.

1.20.5. Welding shall be done in accordance with the latest edition of IS813 and IS814, the Code of Practice for use of Electric Arc welding for general Construction in mild steel. In welding it must be ensured that the base metal is in fused state when filler metal makes contact with it; filler metal does not overflow upon any unfused base metal; base metal is not cut along the weld edges; flowing metal floats the slag, oxide and gas bubbles at the surface behind advance pole. For this, the current shall be adjusted or the electrode size is changed. Welding shall be free from cracks, discontinuity, under or over size welding thickness.

1.20.6. Surface to be welded shall be free from loose mill scale, nut, grease, paint and any other foreign material. As far as possible avoid the welding at heights and at difficult positions. Generally fillet welding is preferred. The parts to be welded are brought in as close contact as practicable and rigidly clamped together.

1.20.7. Before erection, steel work shall be thoroughly cleaned of rust, loose scale, dust, welding slag, and shall be given one coat of zinc chromate primer of approved make and one coat of synthetic enamel paint of approved make as specified in the item before erection and final coat of painting after the erection as directed.

1.20.8. Steel members shall be hoisted and put in position carefully without any damage to the member and to the building and labour. The trusses shall be lifted at such points that they do not buckle or deform or be unduly stressed. The end of the truss which faces the prevailing wind shall be fixed and the other end may be kept free to move. The steel work shall be securely fastened wherever necessary, temporarily braced, to provide for all loads to be carried by the member during erection including the load due to the

erection equipment and its operation. No permanent bolting or welding is done until proper alignment has been obtained. The holes for the rivets shall be determined with the help of templates and drilled. Erection clearance of the cleared ends shall not be more than 1.5 mm and without cleating end clearance shall not be more than 3 mm. Grouting or embedding of structural steel members done after the approval of the alignment, level & position of the members by the Engineer-in-charge.

1.20.9. Important points

1.20.9.1. Before the actual execution of the job, the Contractor shall prepare fabrication drawings for all structural steel work from the structural drawings supplied to him and determine the exact cutting lengths of the members, sizes of gusset plates, welding lengths by marking out on a level platform to full scale.

1.20.9.2. Welding plant, electrodes and other equipments, scaffolding, labour shall be arranged by the Contractor at his cost. Erection equipment of required capacity, sufficient number of spare parts and staff shall be maintained by the Contractor at site at his cost.

1.20.10. Providing & Fixing MS holding down bolts

The MS holding down bolts of specified diameter, length and shape shall be provided as per the drawings to line & level. These shall be fixed to RCC work or brick work by grouting it with concrete. The bolt shall be provided with nuts and washers. The grease shall be applied to the threaded portion with the help of templates. If the bolts need some adjustment it shall be provided with a wooden piece 75x75 mm or 50 mm diameter GI pipe around bolt shall be provided at the time of concreting and shall be removed after initial set.

1.20.11. Providing & Fixing AC Corrugated Sheets

1.20.11.1. AC sheet and accessories shall be free from cracks, chipped edges and corners. The fixing shall be done as per the latest edition of IS 459. The spacing of the purlins shall not be more than 1.4 m for 6 mm sheets. The light shall not be visible from the joints of the AC sheets. The AC sheets to be kept on ceiling shall be placed with smooth side upward and the AC sheets to be put in cladding shall be placed with smooth side outside. The AC sheets shall have at sides a lap of half corrugation and an end lap of 150 mm minimum. The free over hangs at ends shall not be more than 300mm.

1.20.11.2. Hole for 8 mm diameter L or J bolts shall be drilled and not to be punched in the ridge of the corrugation. The diameter of the hole shall not be more than the diameter of the bolt by 1.5 mm. The bolts shall be galvanised J or L hooks polymer coated with one polymer thrust washer and nut with polymer cap. All AC sheet accessories shall be painted or white washed as specified in the item or directed by the Engineer.

1.21. WATER SUPPLY

1.21.1. Applicable codes

1) IS554: Code of practise for dimensions for pipe threads where pressure tight joints are required on the threads.
IS1239: Code of practise for Galvanised mild steel welded pipes

1.21.2. Providing & Laying underground GI pipe line

1.21.2.1. The pipes shall be galvanised mild steel welded pipes and screwed and socketed tubes conforming to the requirements of IS1239, for medium grade. They shall be of the diameter (nominal bore) specified in the description of the item. The sockets shall be designated by the respective nominal bores of the pipes for which they are intended. The pipes and sockets shall be cleanly finished well galvanised in and out and free from cracks surface flaws, laminations, and other defects. All screws, threads shall be clean and well cut. The ends shall be cut cleanly and square with the axis of the tube.

1.21.2.2. All screwed tubes and sockets shall have pipe threads conforming to the requirements of IS551. Screwed tubes shall have taper threads while the sockets shall have parallel threads.

1.21.2.3. The fittings shall be of malleable cast iron or mild steel tubes complying with all the appropriate requirements as specified for pipes. The fittings shall be designated by the respective nominal bores of the pipes for which they are intended. The fittings shall have screw threads at the ends conforming to the requirements of IS551. Female threads on fittings shall be parallel and male threads (except on running nipples and collars of unions) shall be tapered.

1.21.2.1. The pipes and fittings shall be inspected at site before use to ascertain that they conform to the specification. The defective pipes shall be rejected. Where the pipes have to be cut or rethreaded, the ends shall be carefully filed out so that no obstruction to bore is offered. The end of the pipes shall then be threaded conforming to the requirements of IS554 with pipe dies and tapes carefully in such a manner as will not result in slackness of joints when the two pipes are screwed together. The tapes and dies shall be used only for straightening, screw threads which have become bent or damaged and shall not be used for turning of the threads so as to make then slack, as the latter procedure may not result in a water tight joint. The screw threads of pipes and fittings shall be protected from damage until they are fitted.

1.21.2.5. The pipes shall be cleaned of all foreign matter before being laid in jointing the pipes, the inside of the socket and the screwed end of the pipes shall be oiled and rubbed over with white lead and a few turns of spun yarn wrapped round the screwed end of the pipes. The end shall then be screwed in the socket, tee, etc., with the pipe wrench. Care should be taken that all pipes and fittings are properly joined so as to make the joints completely water tight and pipes are kept at all times free from dust and dirt during fixing. Purr from the joint shall be removed after screwing. After the laying, the open ends of the pipes shall be temporarily plugged to prevent access of water, soil or any other foreign matter. Any threads exposed after jointing shall be painted or in the case of underground piping thickly coated approved anticorrosive paint to prevent corrosion.

1.21.2.6. If the galvanised iron pipes and fittings are laid in trenches, the widths and depths of the trenches for different diameters of the pipes shall be as in the table given below:

Diameter of pipe	Width of trench	Depth of trench
15mm to 50mm	30cm	60cm
65mm to 100mm	45cm	75cm

1.21.2.7. At joints the trench width shall be widened where necessary. The work of excavation and refilling shall be done true to line and gradient in accordance with general specifications for each work in trenches. The pipes shall be painted with two coats of anticorrosive bituministic paint of approved quality. **The pipes shall be laid on a layer of 7.5 cm sand and filled up to 15 cm above the pipes. The remaining portion of the trench shall then be filled with excavated earth.** The surplus earth shall be disposed off as directed when excavation is done in rock the bottom shall be cut deep enough to permit the pipes to be laid on a cushion of sand 7.5 cm minimum. In case of bigger diameter pipes where the pressure is very high thrust blocks of cement concrete 1:2:4 (1 cement : 2 coarse sand : 4 grade stone aggregate of 20 mm nominal size) shall be constructed on all bends to transmit the hydraulic thrust without impairing the ground sand spreading it over a sufficient area.

1.21.3. Test

1.21.3.1. After laying and jointing, the pipes and fittings shall be inspected under working conditions of pressure and flow. Any joint found leaking shall be redone and all leaking pipes removed and replaced without extra cost.

1.21.3.2. The pipes and fittings after they are laid shall be tested to hydraulic pressure of 6 kg/sq.cm (60 meter). The pipes shall be slowly and carefully charged with water allowing all air to escape and avoiding all shock or water hammer. The draw off, takes and stop cocks shall then be closed and specified hydraulic pressure shall be applied gradually. Pressure gauge must be accurate and preferably should have been recalibrated before the test. The test pump having been stopped the test pressure should maintain without loss for at least half an hour. The pipes and fittings shall be tested in sections as the work of laying proceeds, keeping the joints exposed for inspection during the testing.

1.21.1. Providing & Laying concealed in structure GI pipe line

1.21.1.1. For internal work the pipes shall be concealed in the brick masonry. Chasses or zarries shall be cut in the walls and the pipes shall be laid. The pipes shall not ordinarily be buried in solid floors. Where unavoidable, pipes may be buried for short distances provided adequate protection is given against damage, but the joints in pipes shall not be buried. Where directed by the Engineer-in-charge, MS sleeve shall be fixed at a place where a pipe is passing through a wall or floor for inception of the pipe and to allow for

expansion movements and contraction and other. In case the pipe is embedded in walls or floors it should be painted with anticorrosive bituministic paint of approved quality. The pipe should not come in contact with lime mortar or lime concrete as the pipe shall be laid in layer of sand filling done under concrete floors or as directed by the Engineer-in-charge. **The floor and wall shall be finished same as the surrounding surface after the completion of the work.**

1.222. SANITARY WORKS

1.22.1. Applicable codes

a. IS458: Code of practise for concrete pipe

b. IS651: Code of practise for salt-glazed stoneware pipes and fittings

c. IS1729: Code of practise for sand and cast iron spigot and socket, soil, waste and ventilating pipes fittings and accessories

d. IS5329: Code of practise for sanitary pipe work above ground for building

e. IS3114: Code of practise for laying cast iron pipes

f. IS1726: Code of practise for cast iron manhole covers and frames

b. IS783: Code of practice for laying of concrete pipes.

a. IS2326: Automatic flushing cisterns for urinals.

b. IS2470: Code of practice for design and construction of septic tanks.

c. IS2556: Vitreous sanitary appliances

d. IS774: Flushing Cisterns for water closets and urinals (valve less siphonic type).

e. IS775: Cast iron brackets and supports for wash basins and sinks.

f. IS781: Sand-cast brass screw-down bib taps and stop taps for water services.

g. IS1068: Electroplated coatings of nickel and chromium on iron and steel.

h. IS1536: Centrifugally cast (spun) iron pressure pipes for water, gas and sewage.

i. IS1626: Asbestos cement building pipes, gutters and fittings (spigot and socket types)

j. IS1703: Ball valves (horizontal plunger type) including floats (spigot and socket types)

k. IS1742: Code of practice for building drainage.

l. IS2470: Code of practice for design and construction of septic tanks.

m. IS2963: Non-ferrous waste fittings for wash basins and sinks.

n. IS.3311 Waste plug and its accessories for sinks and wash basins.

o. IS.5434 Non-ferrous alloy bottle traps for marine use.

1.22.2. Scope of work

The scope of work includes providing and fixing sanitary fixtures, providing and laying drainage lines and all items of work described in Schedule of Quantities.

1.22.3. Drawings

Checked and approved drawings showing location of sanitary and water supply fixtures will be furnished to the Contractor and all drawing so furnished shall form a part of this

specification. The Contractor shall refer these drawings for all information contained thereon which pertains to and required for this work.

1.22.1. All connected works will be measured and paid under respective items of work unless specifically mentioned otherwise.

1.22.5. Providing & Laying non-pressure Hume pipe

1.22.5.1. The pipe shall be with or without reinforcement as required and of the class as specified. These shall conform to IS456. The reinforced cement concrete pipes shall be manufactured by centrifugal (or spun) process while unreinforced cement concrete pipes by spun or pressure process. All pipes shall be true to shape, straight, perfectly sound and free from cracks and flaws, the external and internal surface of the pipes shall be smooth and hard. The pipes shall be free from defects resulting from imperfect grading of the aggregate mixing or moulding. The unreinforced pipes (non pressure pipes) shall withstand a test pressure equivalent to 0.7 kg/sq.cm (7 m head) of water.

1.22.5.2. Concrete used for the manufacture of unreinforced and reinforced concrete pipes and collars shall not be leaner than 1:2:4 (1cement: 2coarse sand: 4 graded stone aggregate). The maximum size of aggregate should not exceed one third of the thickness of the pipe or 20 mm whichever is smaller. The reinforcement in the reinforced concrete pipes shall extend throughout the length of the pipe. The circumferential and longitudinal reinforcements shall be adequate to withstand the specified hydrostatic pressure and further bending stresses due to the weight of water when running full across a span equal to the length of pipe plus three times its own weight. The minimum cover for reinforcement of spun pipes and for all other pipes shall be as given below:

Pipe thickness	Spun pipes (mm)	Pipes other than spun pipe (mm)
Less than 30 mm	9	12
30 mm to 75 mm	12	18
75 mm and over	18	18

1.22.5.3. Where the pipe shall be bedded directly on soil, the bed shall be suitably rounded to fit the lower part of the pipe, the cost for this operation being included in the rate for laying the pipe.

1.22.5.1. Loading, transporting, and unloading of concrete pipes shall be done with care. Handling shall be as to avoid impact. Gradual unloading by inclined plane 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 the line and grade as specified. The laying of the pipe shall proceed upgrade of a slope.

1.22.5.5. If the pipes have spigot and socket joints, the socket ends shall face up-stream. In the case of pipes with joints to be made with loose collars, the collars shall be slipped on before the next pipe is laid. Adequate and proper expansion joints shall be provided where directed.

1.22.5.5.1. In case where the foundation conditions are unusual such as in the proximity of trees or holes under existing or proposed tracks, manholes etc., the pipe shall be encased all-round in 15 cm thick cement concrete 1:5:10 (1 cement : 5 coarse sand : 10 graded stone aggregate 40 mm nominal size) or compacted sand or gravel.

1.22.6. In case where the natural foundation is inadequate the pipes shall be laid either in concrete or cradle supported on proper foundations or on any other suitably designed structure. If a concrete cradle bedding is used the depth of concrete below the bottom of the pipe shall be at least 1/4th of the internal diameter of the pipe subject to a minimum of 10cm and a maximum of 30cm. The concrete shall extend up the sides of the pipes at least at a distance of 1/4th of the outside diameter for pipes 300 cm and over in diameter. The pipe shall be laid in this concrete bedding before the concrete has set, pipes laid in trenches in earth shall be bedded evenly and firmly and as far up the haunches of the pipes as to safely transit the load expected from, the backfill through the pipe to the bed. This shall be done either by excavating the bottom of the trench to fit the curve of the pipe or by compacting the earth under the curve of the pipe to form an even bed. Necessary provision shall be made for joint wherever required. 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 equalising bed of concrete, sand or compacted earth. In no case shall pipe be laid directly on such hard material. When the pipes are laid completely above the ground the foundations shall be made and sufficiently compacted to support the pipe line without any material settlement. Alternatively the pipe line shall be supported on rigid foundations at intervals. Suitable arrangements 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 pole shall be supported as far as possible close to the joints. In no case shall the joint come in the 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. Suitably designed anchor blocks at change of directions and grades for pressure line shall be provided where required.

1.22.6.1. Jointing of the pipes shall be done as described below:

Collar shall be spaced symmetrically over the two pipes and the space between collar and pipe filled with cement mortar 1:1 thoroughly rammed with caulking tools. The joint shall be finished with a fillet sloping at 45_o joints shall be protected and cured for about 10 days. If specified in the item specification wedge shaped groove in the end of the pipe shall be filled with a special bituminous plastic compound for bitumen soaked spun yarn. The collar shall then be slipped over the end of pipe and next pipe butters well against the plastic compound by suitable appliance so as to

compress the plastic compound in the grooves, care being taken not to disturb concentricity and level of the pipes.

1.22.7. Providing & laying stoneware pipe

1.22.8. All pipes with spigot and socket ends shall conform to IS651 and shall be of grade 'A' as specified. These shall be sound, free from visible defects such as fire cracks or hair cracks. The glaze of the pipe shall be free from crazing. The pipes shall give a sharp clear sound when struck with a light hammer. There shall be no broken blisters.

1.22.9. The approximate thickness of 60 cm long pipes shall be as given in the table.

Internal diameter of the pipe (mm)	Thickness of the barrel and socket (mm)	Weight of each pipe per M (kg)
100	12	14
150	16	22
200	17	33
230	19	44
250	20	52
300	25	79
350	30	100
400	35	128
450	38	147

1.22.10. The length of pipes shall be 60 cm exclusive of the internal depth of the socket. The pipe shall be handled with sufficient care to avoid damage to them.

1.22.11. All pipes shall be laid on a bed of 15 cm cement or lime concrete as specified, projecting on each side of the pipe to the width of the trench which shall be nominal diameter of pipe + 400 mm. The pipes with their crown level at 1.20 m depth and less from ground shall be covered with 15 cm thick concrete above the crown of the pipe and sloped off to meet the outer edges of the concrete, to give a minimum thickness of 15 cm all round the pipe. Pipes laid at a depth greater than 1.20 m at crown shall be concreted at the side up to the level of the centre of the pipe and sloped off from the edges to meet the pipe tangentially. The concreting shall be done as per specifications for concrete. The pipes shall be carefully laid to the alignment levels and gradients shown on the plans and sections, great care shall be taken to prevent sand, etc., from entering the pipes. The pipes between two manholes shall be laid truly in a straight line without vertical or horizontal undulation. The pipe shall be laid with socket up the gradient. The body of the pipe shall for its entire length rest on an even bed of concrete and places shall be formed in the concrete to receive the socket of the pipe.

1.22.12. Where pipes are not bedded on concrete the trench floor shall be left slightly high and carefully bottomed up as pipe laying proceeds, so that the pipe barrels rest on firm and undisturbed ground. If the excavation has been carried to below the desired

levels, shall be made up with concrete 1:5:10 (1 cement: 5 coarse sand: 10 graded brick bat of 40 mm nominal size) for which no extra payment shall be made.

1.22.13. If the floor of the trench consists of rock or very hard ground that cannot easily be excavated to a smooth surface the pipe shall be laid on a levelling course of concrete as desired. When SW pipes are used for storm water drainage, no concreting will normally be necessary. The cement mortar for jointing will be 1:3 (1cement: 3 fine sand), testing of joints will also not be done.

1.22.11. Tarred gasket of hemp yarn soaked in thick cement slurry shall first be placed round the spigot of each pipe and the spigot shall then be slipped home well into the socket of the pipe previously laid. The pipe shall then be adjusted and fixed in the correct position and the gasket caulked tightly home so as to fill not more than 1/4th of the total depth of the socket.

1.22.15. The reminder of the socket shall be filled with stiff mixture of cement mortar in the proportion of 1:1 (1 cement: 1 fine sand) when the socket is filled, a fillet shall be formed round the joint with a trowel forming an angle of 45o with the barrel of the pipe. After a day's work an extraneous material shall be removed from the inside of the pipe. The newly made joints shall be cured.

1.22.16. Water Test

1.22.16.1. Stoneware pipes used for sewers shall be subjected to a test pressure of 1.5 m head of water at the highest point of the section under test. The test shall be carried out by suitably plugging the low end of the drain and the ends of the connection if any and filling the system with water. A buckle bend shall be temporarily jointed in at the top end and a sufficient length of vertical pipe jointed to it so as to provide the required test head. Or the top may be plugged with a connection to a hose ending in a funnel which could be raised or lowered till the required head is obtained and fixed suitably for observation. Where leakage will be visible the defective part of the work shall be removed and made good.

1.22.16.2. In cases where pipes are not bedded in concrete special care shall be taken in refilling trenches to prevent the displacement and subsequent settlement at the surface resulting in uneven street surfaces and dangers to foundations, etc. The backfilling materials shall be packed by hand under and around the pipe, and rammed with a shovel and light tamper. The method of filling will be continued up to the top of pipe. The refilling shall rise evenly on up to the top of pipe. The refilling shall rise evenly on both sides of the pipe continued up to 60 cm above the top of pipe so as not to disturb the pipe. No tamping should be done within 15 cm of the top of pipe. The remainder of the backfill shall not be done until 7 days have elapsed for brick sewers and 14 days for concrete sewers, unless local conditions or materials are suitable for the earlier placing of load on the pipes. The tamping shall become progressively heavier as the depth of the backfill increases.

1.22.16.3. In measuring the length of sewer pipes, laid length between faces of manholes shall only be measured omitting lengths of channels between inside faces of walls of manholes or chambers.

1.22.17. Providing & Laying CI WW line concealed in structure with cement joint

1.22.17.1. All cast iron pipes and fittings shall be of approved ISI make, shall be of uniform thickness with strong and deep sockets, free from flaws, air holes, cracks, hand holes and other defects and conform, to IS1729. The pipes and fittings shall be true to shape, smooth and cylindrical and shall ring clearly when struck over with a light hand hammer. All pipes and fittings shall be properly cleaned of all foreign material before being fixed.

1.22.17.2. The annular space between the socket and spigot shall be filled with a gasket of hemp or spun yarn soaked in neat cement slurry. The joint shall then be filled with stiff cement mortar 1: 2 (1 cement: 2 fine sand) well pressed with caulking tool and finished smooth on top at an angle of 45o. The joint shall be kept wet for not less than 7 days by tying a piece of gunny bag and kept moist. Joints shall be perfectly air and water tight.

1.22.17.3. The thickness of fittings and their socket and spigot dimensions shall conform to the thickness and dimensions specified for the corresponding sizes of straight pipes.

1.22.17.1. The connection between the main pipe and branch pipes shall be made by using branches and bends with access doors for cleaning. Floor traps shall be provided with 25 mm dia puff pipe where the length of the waste is more than 1800 mm or the floor trap is connected to a waste stack through bends.

1.22.17.5. All cast iron pipes and fittings including joints shall be tested by a smoke test to the satisfaction of the Engineer and left in working order after completion. The smoke test shall be carried out as stated under:-

1.22.17.6. Smoke shall be pumped into the pipe at the lowest end from a smoke machine, which consists of a bellow and burner. The material usually burnt is fresh cotton waste which give out a clear pungent smoke which is easily detectable sight as well as by smell if there is leaking at any point of the pipeline.

1.22.18. Water test and air test shall be conducted as stipulated in IS5329.

1.22.19. Providing & Laying concealed PVC rain water line

The strength of the pipe shall be 4kg/sq cm. It shall be of approved make. It shall be provided with all necessary specials. It shall be jointed with adhesive as per the manufacturer's specifications.

1.22.20. Providing & constructing manholes

1.22.20.1. Manholes of different types and sizes as specified shall be constructed in the sewer line at such places and to such levels and dimensions as shown in the drawings or as directed by the engineer. The size indicates the inside dimensions of the manhole.

1.22.20.2. Excavation and back filling shall be as per respective specifications.

1.22.20.3. Manhole shall be built on a bed of brickbat cement concrete 1:4:8 (1 cement: 4 sand : 8 brickbats of 40mm nominal size). The thickness of the bed concrete shall be 150mm unless otherwise specified.

1.22.20.1. Brick work shall be in cement mortar 1:6 (1cement: 6 sand). The external joints of the brick masonry shall be finished smooth. The joints of the pipes with the masonry shall be made perfectly leak-proof with cement concrete 1:2:1.

1.22.20.5. The brick walls of the manholes shall be plastered inside with 12mm thick cement plaster 1:4 (1 cement: 4 sand) finished smooth with a floating coat of neat cement.

1.22.20.6. Channels and benching shall be in cement concrete 1:2:4 (1cement: 2 sand: 4 graded stone aggregate).

1.22.20.7. All manholes deeper than 1.0m shall be provided with CI foot rest. These shall be embedded 20 cm deep with 20x20x10 cm blocks of cement concrete 1:2:4 (1 cement : 2 sand : 4 graded stone aggregate). The block with CI foot rest placed in its centre shall be cast-in-situ along with the masonry and the surface finished with 12mm thick cement plaster 1:4 (1 cement : 4 sand) finished smooth. Foot rests shall be fixed 30cm apart vertically and staggered the wall. The top foot rest shall be 45 cm below the manhole cover. Foot rests shall be painted with coal tar, the portion embedded in cement concrete block painted with thick cement slurry before fixing.

1.22.20.8. The depth of channels and benching shall be as indicated in the table given below.

Internal diameter of the pipe (mm)	Thickness of the barrel and socket (mm)	Weight of each pipe per M (kg)
100	12	14
150	16	22
200	17	33
230	19	44
250	20	52
300	25	79
350	30	100
400	35	128
450	38	147

1.22.21. CI manhole covers and frames shall conform to IS1726. The covers and frames shall be cleanly cast and they shall be free from air and sand holes and from cold struts.

They shall be neatly dressed and carefully trimmed. All casting shall be free from voids whether due to shrinkage, gas inclusion or other causes. Cover shall have a raised chequered design on the top surfaces to provide an adequate non slip grip. The cover shall be capable of easy opening and closing. It shall be fitted in the frame in workmanship like manner. The cover shall be gas tight and water tight. Covers and frames shall be coated with a black bituminous paint. It shall not flow when exposed to a temperature of 63 Degree Centigrade and shall not be brittle as to chip off at temperature of 0 Degree Centigrade.

1.22.22. Manhole cover and frame shall conform to medium duty of 500 mm internal diameter and shall weigh not less than 75kg unless otherwise mentioned in the item description. (Weight of cover 58kg and weight of frame 58kg).

1.22.23. Manholes shall be measured in numbers. The depth of the manhole shall be reckoned from top level of CI cover to the invert levels of channel. The depth shall be measured correct to centimetres.

1.22.21. Sewers of unequal sectional area shall not be jointed at the same invert level in a manhole. The invert of the smaller sewer at its junction with main shall be, at a height at least 2/3 the diameter of the main, above the invert of the main. The branch sewer should deliver sewage in the manhole in the direction of main flow and the junction must be made with care so that flow in the main is not impeded. No drains from house fittings for example GT, soil pipe etc. exceeding a length of 6m shall be connected unless it is inevitable.

1.22.25. The frame of the manhole cover shall be firmly embedded to correct alignment and levels in plain cement concrete 100mm thick 1:2:4 (1 cement :2 sand :4 graded stone aggregate) on top of the brick masonry. After completion of the work manhole covers shall be smeared by means of thick grease.

1.22.26. Providing & Constructing Soak pit

The earth excavation shall be carrying out to the exact dimensions as shown in the drawing. The soak pit shall be constructed of honey-comb dry brick work of 250 mm thick in cement mortar 1:6, RCC 1:2:4 precast or cast-in-situ slabs 150 mm thick for top cover with reinforcement, CI manhole cover 500 mm diameter of 80 kg weight, 150 mm diameter SW tee, outlet vent, 75 mm diameter CI pipe 2 m high fixed on masonry pedestal with cowl and bituministic painting, refilling, watering, consolidating etc., all complete.

1.22.27. Providing & Constructing Drop connection

1.22.27.1. In cases where branch sewer enters the manholes of main pipe sewer at a higher level than the main sewer, a drop connection should be provided. Pipes and specials conforming to IS1729 shall be of the same size as the branch pipe sewer.

1.22.27.2. For 150 mm and 250 mm main line if the difference in level between the water line (peak flow level and the invert level) of branch line is less than 60 cm a drop connection may be provided within the manhole by giving a suitable ramp. If the difference in level is more than 60 cm the drop should be provided externally.

1.22.27.3. The excavation shall be done for the drop connection at the place where the branch line meets the manhole. The excavation shall be carried up to the bed concrete of the manhole and to the full width of the branch line excavation and backfilling shall be done as per respective specifications.

1.22.27.1. At the end of branch sewer line SCI tee shall be fixed to the line which shall be extended through the wall of manhole by a horizontal piece of SCI pipe to form an inspection of cleaning eye. The open end shall be provided with chain and lid. The SCI drop pipe shall be connected to the tee at the top and to the SCI bend at the bottom. The bend shall be extended through the wall of the manhole by a piece of pipe which shall discharge into the channel. Necessary channel shall be made with cement concrete of grade M-150 and finished smooth to connect the main channel. The joint between CI pipe and fittings shall be lead caulked. The joint between SCI tee and SW branch line shall be made with cement mortar 1:1 (1 cement: 1 fine sand) as for emased all round with minimum 15 cm thick concrete 1:5:10 (1 cement: 5 coarse sand: 10 graded stone aggregate 40 mm nominal size) and cured. For encasing the concrete around the drop connection the necessary centering and shuttering shall be provided the holes made in the walls of the manhole shall be made good with brick work in cement mortar 1:5 (1 cement: 5 coarse sand) and plastered with cement mortar 1:3 (1 cement: 3 fine sand) on the inside of the manhole wall. The excavated earth shall be back filled in the trench in level with the original ground level.

1.22.28. Providing & Constructing Road gully chambers/yard gully

1.22.28.1. The chamber shall be of brick masonry and shall have a CI grating with frame fixed in 150 mm thick cement concrete of grade M-15 at the top. The size of the chamber shall be taken as clear internal dimensions of the CI frame. The chamber shall have a SW connection pipe, the length of which between road gully chamber and the point of discharge to drain or to open ground shall be measured separately. The chamber shall be built at the locations indicated in drawings.

1.22.28.2. Bed concrete, brick work, plastering, RCC work, excavation, backfilling, etc. shall be as per details given on the drawing and in compliance with the requirements laid down in the specifications for the respective items.

1.22.28.3. The MS grating cover shall be hinged to the frame to facilitate its openings for cleaning and repairs. The weight of grating shall be 75 kg minimum.

1.22.28.1. After the completion of the work the exposed surfaces of the grating and the frame shall be painted with two coats of synthetic enamel paint.

1.23. LIST OF APPROVED BRAND / MAKE

Description	Approved Brand / Make

Cement	Malabar/ Ultratech/ ACC/ India Cements/Dalmiya or equivalent approved by INKEL
Steel	SAIL/ TISCO/ IISCO/ Vizag or equivalent approved by INKEL
Paints & Distemper	ICI/Berger/AsianPaints/Garware/Jenson & Nicholson/Dulex/Jotun or equivalent approved by INKEL
Primer	Berger / Asian
Water proofing cement paint	Super Snowcem / Super Shelcem
Floor / Wall Tiles	Orient Bell/ Johnson/ Nitco/ Somany /Cera or equivalent approved by INKEL

TECHNICAL SPECIFICATIONS - PLUMBING AND SANITARY INSTALLATIONS

Codes and Standards to be followed.

1. NBC of India
2. Uniform Plumbing Code of India
3. IGBS Guidelines
4. Relevant BIS, as under

IS 771 (Part 1):1979 Specification for glazed fire-clay sanitary appliances: Part 1 General requirements

IS 771(Part 2):1985 Specification for glazed fire-clay sanitary appliances: Part 2 Specific requirements of kitchen and laboratory sinks

IS 771 (Part 3/Sec 1):1979 Specification for glazed fire clay sanitary appliances : Part 3 Specific requirements of urinals, Section 1 Slab urinals

IS 771(Part 3/Sec 2):1985 Specification for glazed fire-clay sanitary appliances: Part 3 Specific requirements of urinals: Section 2 Stall urinals

IS 771 (Part 4):1979 Specification for glazed fire-clay sanitary appliances: Part 4 Specific requirements of postmortem slabs

IS 771 (Part 5):1979 Specification for glazed fire clay sanitary appliances: Part 5 Specific requirements of shower trays

IS 771 (Part 6):1979 Specification for glazed fire-clay sanitary appliances: Part 6 Specific requirements of bedpan sinks

IS 771 (Part 7):1981 Specification for glazed fire-clay sanitary appliances: Part 7 Specific requirements of slop sinks.

IS 772:1973 Specification for general requirements for enameled cast iron sanitary appliances
IS 774:2004 Specification for flushing cistern for water closets and urinals (other than plastic cistern).

IS 778:1984 Specification for copper alloy gate, globe and check valves for water works purposes

IS 779:1994 Specification for water meters (domestic type)

IS 781:1984 Specification for cast copper alloy screw down bib taps and stop valves for water services

IS 782: 1978 Specification for caulking lead

IS 1172: 1993 Code of basic requirements for water supply, drainage and sanitation?

IS 1701:1960 Specification for mixing valves for ablutionary and domestic purposes

IS 1703: 2000 Water fittings – copper alloy float valves (horizontal plunger type) – Specification

IS 1711: 1984 Specification for self-closing taps for water supply purposes

IS 1726: 1991 Specification for cast iron manhole covers and frames

IS 1742: 1983 Code of practice for building drainage.

IS 1795: 1982 Specification for pillar taps for water supply purposes

IS 2064: 1993 Code of practice for selection, installation and maintenance of sanitary appliances.

IS 2065: 1983 Code of practice for water supply in buildings

IS 2326:1987 Specification for automatic flushing cisterns for urinals (other than plastic cisterns)

IS 2373:1981 Specification for water meters (bulk type)

IS 2470 (Part 1):1985 Code of practice for installation of septic tanks: Part I design, criteria and construction

IS 2470 (Part 2):1985 Code of practice for installation of septic tanks: Part 2 Secondary treatment and disposal of septic tank effluent

IS 2548 (Part 1):1996 Specification for plastic seats and covers for water-closets: Part 1 Thermoset seats and covers

IS 2548 (Part 2):1996 Specification for plastic seats and covers for water-closets: Part 2 Thermo plastic seats and covers

IS 2556 (Part 1):1994 Specification for vitreous sanitary appliances (vitreous china): Part 1 General requirements

IS 2556 (Part 2):2004 Specification for vitreous sanitary appliances (vitreous china): Part 2 Specific requirements of wash-down water-closets

IS 2556 (Part 3):2004 Specification for vitreous sanitary appliances (vitreous china): Part 3 Specific requirements of squatting pans

IS 2556 (Part 4):2004 Specification for vitreous sanitary appliances (vitreous china): Part 4 Specific requirements of wash basins

IS 2556 (Part 5):1994 Specification for vitreous sanitary appliances (vitreous china): Part 5 Specific requirements of laboratory sinks.

IS 2556 (Part 6):1995 Specification for vitreous sanitary appliances (vitreous china): Part 6 Specific requirements of urinals and partition plates

IS 2556 (Part 7):1995 Specification for vitreous sanitary appliances (vitreous china): Part 7 Specific requirements of accessories for sanitary appliances

IS 2556 (Part 8):2004 Specification for vitreous sanitary appliances (vitreous china): Part 8 Specific requirements of pedestal close coupled wash-down and siphonIc water closets

IS 2556 (Part 9):2004 Specification for vitreous sanitary appliances (vitreous china): Part 9 Specific requirements of pedestal type bidets

IS 2556 (Part 14):1995 Specification for vitreous sanitary appliances (vitreous china): Part 14 Specific requirements of integrated squatting pans

IS 2556 (Part 15):2004 Specification for vitreous sanitary appliances (vitreous china): Part 15 Specific requirements of universal water closets

IS 2556 (Part 16):2002 Specification for vitreous sanitary appliances (vitreous china): Part 16 Specific requirements for wash down wall mounted water closets

IS 2556 (Part 17):2001 Specification for vitreous sanitary appliances (vitreous china): Part 17 Specific requirements for wall mounted bidets

IS 2685:1971 Code of practice for selection, installation and maintenance of sluice valves.

IS 2963:1979 Specification for copper alloy waste-fittings for wash basins and sinks

IS 3004:1979 Specification for plug cocks for water supply purposes

IS 3006:1979 Specification for chemically resistant glazed stoneware pipes and fittings

IS 3042:1965 Specification for single faced sluice gates (200 to 1200 mm size)

IS 3114:1994 Code of practice for laying of cast iron pipes.

IS 3311:1979 Specification for waste plug and its accessories for sinks and wash-basins.

IS 3950:1979 Specification for surface boxes for sluice valves

IS 4038:1986 Specification for foot valves for water works purposes

IS 4111(Part 1):1986 Code of practice for ancillary structures in sewerage system: Part I Manholes

IS 4111(Part 2):1985 Code of practice for ancillary structures in sewerage system: Part II Flushing tanks

IS 4111(Part 3):1985 Code of practice for ancillary structures in sewerage system: Part III Inverted syphon

IS 4111(Part 4):1968 Code of practice for ancillary structures in sewerage system: Part 4 Pumping stations and pumping mains (rising mains)

IS 4111(Part 5):1993 Code of practice for ancillary structures in sewerage system: Part 5 Tidal outfalls

IS 4127:1983 Code of practice for laying of glazed stoneware pipes.

IS 4346:1982 Specification for washers for use with fittings for water services

IS 5219 (Part 1):1969 Specification for cast copper alloys traps: Part 1 ‘P’ and ‘S’ traps

IS 4985, 2000, Specification for Un plasticized Pipes for Potable Water Supplies

IS 5312(Part 1):2004 Specification for swing check type reflux (non- return) valves: Part 1 Single door pattern

IS 5312(Part 2):1986 Specification for swing check type reflux (non-return) valves for water works purposes: Part 2 Multi-door pattern

IS 5329:1983 Code of practice for sanitary pipe work above ground for buildings.

IS 5382:2003 Specification for Dimensional Requirement for Rubber Sealing Ring for Water Mains

IS 5455:1969 Specification for cast-iron steps for manholes

IS 5961:1970 Specification for cast iron gratings for drainage purposes

IS 6280:1971 Specification for sewage screens

IS 6411:1985 Specification for gel-coated glass fibre reinforced polyester resin bath tubs

IS 6784:1996 Method for performance testing of water meters (domestic type)

IS 7231:1994 Specification for plastic flushing cisterns for water closets and urinals

IS 7558:1974 Code of practice for domestic hot water installations.

IS: 7834 Specification for Injection Moulded PVC Fitting with Solvent Cement Joints for Water Supplies

IS 8413(Part 2):1982 Requirements for biological treatment and equipment: Part 2 Activated sludge process

IS 8419(Part 1):1977 Requirements for filtration equipment: Part 1 Filtration media – sand and gravel

IS 8419(Part 2):1984 Requirements for rapid sand gravity filtration equipment: Part 2 Underdrainage system

IS 8931:1993 Specification for copper alloy fancy single taps, combination tap assembly and stop valves for water services IS 9140:1996 Method of sampling of vitreous and fire clay sanitary appliances.

IS 9110:1979 Specification for hand operated augers for cleaning water-closets pipes and sewers

IS 9222(Part 1):1990 Recommendations for handling and dosing devices for chemicals for water treatment: Part I Coagulants

IS 9338:1984 Specification for cast iron screw-down stop valves and stop and check valves for water works purposes

IS 9739:1981 Specification for pressure reducing valves for domestic water supply systems

IS 9758:1981 Specification for flush valves and fittings for water closets and urinals

IS 9762:1994 Specification for polyethylene floats (spherical) for float valves

IS 9763:2000 Plastic bib taps, pillar taps, angle valves and stop valves for hot and cold water services Specification

IS 10037(Part 1):1981 Requirements for sludge dewatering equipment: Part I Sludge drying beds-sand and gravel

IS 10037 (Part 2):1983 Requirements for sludge de-watering equipment: Part 2 Vacuum filtration equipment

IS 10037 (Part 3):1983 Requirements for sludge de-watering equipment: Part 3 Centrifugal equipment (Solid bowl type)

IS 10261:1982 Requirements for settling tank (clarifier equipment) for waste water treatment

IS 10313:1982 Requirements for settling tank (clarifier equipment) for water treatment plant?

IS 11117:1984 Requirements for power driven rodding machine for sewers

IS 11208:1985 Guidelines for registration of plumber

IS 11972:1987 Code of practice for safety precautions to be taken when entering a sewerage system

IS 12183(Part 1):1987 Code of practice for plumbing in multi-storeyed buildings: Part 1 ` Water supply

IS 12251:1987 Code of practice for drainage of building

IS 12288:1987 Code of practice for use and laying of ductile iron

SP 35(S&T): 1987 Handbook on water supply and drainage with special emphasis on plumbing.

IS 12234:1988 Specification for plastic equilibrium float valve for cold water services

IS 12701:1996 Specification for rotational moulded polyethylene water storage tanks

IS 13049:1991 Specification for diaphragm type (plastic body) float operated valves for cold water services

IS: 13095: 10101 Mark, slim seal standard lever operated type confirming with required

IS 13114:1991 Specification for Butterfly Valves for General Purpose.

IS 13349:1992 Specification for single faced cast iron thimble mounted sluice gates

IS 13592: 19902, Specification for Type - B, solvent cement

IS 13983:1994 Specification for Soil, Waste, Vent and Rain Water Rain Water Piping.

IS 14735:1994 Specification for Un Plastisie Moulded Fitting for Soil, waste, Vent and Rain Water Rain Water Piping.

IS 14845:2000 Resilient seated cast iron air relief valves for water works purposes – Specification

IS 14846:2000 Sluice valves for water works purposes (50-1200 mm) – Specification

IS 15778 Specification for Chlorinated Polyvinyl Chloride Pipes for Cold and Hot water Distribution Supplies.

Standard for High Pressure uPVC Sch. 80 Pipes: ASTM D 1785)

Standard for High Pressure uPVC Sch. 80 Fittings: ASTM D 2467

GENERAL

The Drawings, Specification and Bill of Quantities, attached, are the essential parts of this tender and should be treated as complementary to each other. Any work or details shown in one and not mentioned in others, by over sight or by any other reasons, should be treated as the part of the Contract, as if it is occurring in all other complementary documents. The higher specifications seen, only, in any of the above documents will over rule the specifications in other complementary documents.

The proposed Building shall be a 'GREEN FACTORY BUILDING' to IGBC Rating.

Water Efficiency has an important factor for getting the required Rating. Hence Plumbing and Sanitary Installations has got an important role in getting the required rating.

Water usage in the building to be reduced to 40% less than that for a base building to local standards.

To achieve the above water efficiency Dual Plumbing System and High Water Efficient Sanitary Fixtures and Faucets are proposed for the building.

The sanitary fixtures and tap fittings required shall be with following flushing/washing/flow rate.

- Water Closet : 2 /4 LPF
- Urinal : 0.75 LPF or Less
- Wash Basin : 6 LPM or Less
- Kitchen Sink : 6 LPM
- Shower : 9 LPM
- Ablution Faucet : 6 LPM or Less

2.1 SANITARY FIXTURES AND TAP (CP) FITTINGS

All Sanitary fixtures shall of IGBC / Green Rated with (or compatible) for above flushing/flow rate and shall be measured in numbers of unit.

Rates for each items under specification shall include, supply, fix at site in position, test and commission Concerned Sanitary Fixtures complete with necessary fixing accessories such as flush pipes, stainless steel/CP brass screws, rag bolts, expansion sleeves, nuts, washers, brackets and any other fixing arrangements required, as per manufacturer's instructions and consumables required . The rate shall also be inclusive of cutting holes, chases etc. and making good the walls, floors etc, wherever required.

Core cutting in RCC structures shall be measured separately.

2.1.1 EUROPEAN WATER CLOSET

EWC shall be IGBC /Green Rated White Glazed Vitreous China Extended Wall Mounted type, as per IS: 2556, complete Set with 'S' Trap, 2/4 LPF Dual Cistern, including Cistern Fittings, Soft Close Seat Cover, bolts, nuts, washers, Expansion Sleeves, gasket etc.

2.1.2 TOILET FOR DISABLED

Disabled Toilet shall be a Complete Set, including White Floor Mounted Water Closet, Plastic Cistern, Lid, Antimicrobial Seat Cover etc., Wash Basin, Faucet/ Tap with spatula lever and with 1 Set of Hinged Arm, 760mm. long, 4 Set of Grab Rail, each of 600mm. long, and with all necessary accessories and fixed with Brackets Expansion Sleeves, Stainless Steel/ Brass Bolts/Screws, Nuts, Washers etc., including cutting and making good the walls and floors wherever required. Including cutting and making good the walls and floors wherever required.

The total unit shall be rated for Disabled Person, from reputed manufacturers.

2.1.3 WASH BASIN

Wash basins shall be White Glazed Vitreous China Counter Top/Bottom, Oval Shape Vanity Basin, compatible for a washing rate of 6 LPM or less, overall size: 56x41cm, or equal, with C.P. Waste Couplings, CP ABS P - Trap and C.P. Brass chain with rubber plug etc.

2.1.4 URINAL

Urinal shall be IGBC /Green Rated with Integral P-Trap and with Integrated Electronic Flushing System with Passive and Extra Sensitive Infra-Red Sensor (with Battery / AC Operated, as per final requirement), of approved shape and size, having pre & post flushing with water, with a Total Flushing Rate of 0.75 LPF (250 ml & 500 ml respectively), and with water inlet from back side, including fixing to wall with suitable brackets, all as per manufacturer's specification and direction of Engineer-in-charge.

2.1.5 BATH ROOM/TOILET ACCESSORIES

Bath Room/Toilet accessories such as towel rail, towel ring, robe hook, toilet paper holder, towel dispenser, soap dispenser hand drier etc. shall be measured in numbers of unit as per final requirement at site.

Rates for each item under specification shall include fix at site in position and commission, concerned accessories complete with connected fittings, supplied by the client and the rate shall be inclusive of supply of fixing accessories such as stainless steel/CP brass screws, bolts, nuts, washers, brackets and any other fixing arrangements required, as per manufacturer’s instructions and consumables required. The rate shall also be inclusive of cutting holes, chases etc. and making good the walls, floors etc, wherever required.

2.1.6 TAP (CP) FITTINGS AND ACCESSORIES.

All required Tap Fittings shall IGBC /Green Rated with following controlled/restricted flow rates. All Tap fittings shall be chromium plated, with necessary fixing accessories.

- Pillar Tap for Wash Basins shall be Self-Closing Type with Pre Set flow time 6 Sec, with a controlled flow rate of 6 LPM or less.

- Mixer Tap for kitchen sink shall be single lever with restricted/controlled flow rate of 6 LPM, or less.
- Shower/Bath Set shall be with controlled flow rate of 9 LPM or less, complete with Concealed Mixer, Diverter, Bath Spout and 5 Flow Head Shower etc.

- Kitchen Sink Mixer shall be with controlled flow rate of 9 LPM or less, with Swinging Casted Spout.
- Ablution Faucet shall be with controlled flow rate of 6 LPM or less.
- Kitchen / Bath Tap shall be with controlled flow rate of 6 LPM or less

All other Accessories such as P - Traps, Angle Valves, and Waste Couplings etc. shall be of Chrome Plated.

CP Items will be measured in numbers of unit.

Rates for each items under specification shall include supply, fix at site in position, test and commission, Concerned Fittings complete inclusive of supply of stainless steel/CP brass screws, bolts, nuts, washers, brackets and any other fixing arrangements required, as per manufacturer's instructions and consumables required. The rate shall also be inclusive of cutting holes, chases etc. and making good the walls, floors etc, wherever required.

2.2 DRAINAGE SYSTEMS.

There shall be separate piping system for soil, waste and kitchen waste drainage, as detailed in the tender drawings.

All materials shall be new and of the best quality conforming to specifications. Contractor should study the soil, waste and vent systems drawings and site plan drawings thoughrly, for getting a clear view of the proposed system.

All Pipes shall be cut, cleaned and jointed (pipes together and pipes and fittings) in a neat manner, as per manufacturers instructions and to the approval of consultants.

All pipes shall be fixed in position, at site, as per details in the approved working drawings, with specified gradient and spacing. The spacing for pipe supports shall be as detailed in the drawings.

Pipe work shall be fixed in a neat manner as to provide easy accessibility for repair and maintenance and shall not cause obstruction in shafts, passages etc. The vertical risers shall be parallel to walls and columns and shall be straight and plumb.

The item "Pipe Work" shall be inclusive of supply, fix at site (concealed in walls, RCC structure, ceiling voids etc. and exposed, horizontally and vertically, on walls, roof slabs, in ducts etc. and laying in underground, with appropriate pipe clamps, pipe supports, hanging supports, fasteners, concrete supports, thrust blocks etc), water/gravity testing, anti corrosive and weatherproof protective coatings and encasing/wrapping, as per requirements, and commissioning.

Rates for Pipes will be measured in unit rate per linear meters and inclusive of all fittings, such as

Elbows, Tees, Y-Joints, Reducers, Sockets, Flanges, Pipe Supports, Clamps, Expansion Joints, Bolts, washers, Nuts etc, as per requirement and site conditions.

The rate for concealed pipe work shall be inclusive of cutting, chasing drilling etc. through all types of walls /floors and finishing for all services crossings, including sealing, frame works, fire proofing with approved fire resistant materials, providing sleeve, cover plates, making good structure and finishes to an approved standard etc. in a neat manner to the approval of Engineer – in – Charge.

Core cutting in RCC Structures, as per requirement shall be measured separately.

Exposed pipe work shall be fixed on walls, roof slabs, columns etc. with approved G.I. Supporting Systems consisting of slotted rails, U-clamps, saddle clamps, fastners, hanging rods, bolts washers, nuts etc, as per requirement, in a neat manner, to the approval of Consultant and PMC.

All fittings shall be of the required degree of curvature with or without access door as required in the approved drawings.

Clean Outs and Roding Points shall be provided at the beginning of a new junction, and as per details in the approved working drawings.

Anti syphonic pipes shall be provided to the soil stack fixed at the outer walls.

Contractor shall provide all sleeves, openings, hangers, and inserts during the construction. He shall provide the necessary information to the building contractor for making such provisions in the structure necessary. All damages shall be made good to restore the surfaces.

All the drainage pipe work after installation shall be water/gravity tested, by filling with water, in parts or as a whole, for 24 hours, as instructed by the Engineer – in – Charge and System consultant and as when demanded by the client and consultant.

All openings and connections shall be suitably closed/plugged before filling with water.

The pipe work, as a whole, shall be once again being tested for a minimum period of 24 hours, before commissioning of the total Systems.

All Cutting, chasing and drilled/cut holes in the floor slabs for fixing sanitary fixtures, accessories, floor traps, concealed traps and drainage connections for the same should be made thoroughly water tight, along with the floor slab and sunken area, by advanced and latest technology for water proofing.

For details of external work, see. 2.7

2.2.1 PIPE WORK FOR SOIL AND WASTE.

All Concealed Pipe work, for internal drainage, up to 63mm. OD shall be with uPVC Pipes 6Kg/Cm2 (IS: 4985) and injection moulded PVC fittings (IS: 7834) and above 63mm. OD. shall be with uPVC SWR, conforming to IS: 13592, Type-B, Solvent Welded Type Pipes and SWR Solvent Welded Type Fittings. Joining/fixing shall be with heavy duty uPVC solvent cement/adhesive, from the same manufactuturer, for pipes and fittings. All jointing shall be strictly as per manufacturers instructions. Curing time for adhesive joints shall be 24 hours and pipe work will be permitted to use only after 24 hours.

Pipes for Vertical Stacks shall be of Ring Fit uPVC (SWR), with rubber gaskets over sockets, conforming to IS 13592: 1992, Type-B. Fittings shall be SWR Moulded fittings, conforming to IS 14735: 1999, with ring seal adaptors over sockets, conforming to IS 5382. Approved lubricant is advisable for fixing/joining pipes and fittings.

All Under Ground Pipes shall be of uPVC, conforming to IS 4985: 2000, with working pressure 6Kg. / Cm2. Fittings, if required, shall be injection moulded fittings, conforming to IS 7834: 1987. Fixing shall be with heavy duty uPVC solvent cement/adhesive, from the same manufactuturer, for pipes and fittings.

2.2.2 PIPE WORK FOR KITCHEN WASTE DRAINAGE.

Pipe Work for Kitchen Waste Drainage shall be with Cast Iron (Centrifugally Cast) Pipes and Fittings to IS: 3989 such as bends, tees, couplers, Y-junctions, reducers, adaptors, sockets, end plugs, required Floor/P traps etc. jointed with Drip Seal and fixing in position with clamps, fasteners, masonry supports etc, as per requirement.

All Cast Iron floor traps shall be with deep seal.

All jointing and installation shall be strictly as per manufacturer’s instructions.

2.2.3 PIPES FOR VENT SYSTEM.

Pipes for Vent in vertical shafts shall be of Ring Fit UPVC (SWR), with rubber gaskets over sockets, conforming to IS 13592: 1992, Type-A. Fittings shall be SWR Moulded fittings, conforming to IS 14735: 1999, with ring seal adaptors over

sockets, conforming to IS 5382. Approved lubricant is advisable for fixing/joining pipes and fittings.

Vent pipes concealed in walls up to 63mm. OD shall be with uPVC Pipes 6Kg/Cm2 (IS: 4985) and

injection moulded PVC fittings (IS: 7834). Vent pipes concealed in wall and ceiling void above 63mm. OD. shall be with uPVC SWR, conforming to IS: 13592, Type-B, Solvent Welded Type Pipes and SWR Solvent Welded Type Fittings. Joining/fixing shall be with heavy duty uPVC solvent cement/adhesive, from the same manufacturer, for pipes and fittings.

2.2.4 FLOOR TRAPS.

Plain Floor Taps shall be of PVC construction, **4" x 7" Height, Deep Seal Type**, with 75mm. outlet and with Stainless Steel top and strainer.

Multi Floor Traps shall be of PVC construction, **4" x 7" Height, Deep Seal Type** with 50/75mm. inlet and 75 mm. outlets and with Stainless Steel top and strainer.

Floor Drains s shall be of PVC construction with double water seal, 50/63mm. outlet and with Stainless Steel top and strainer.

All Cast Iron floor traps shall be with deep seal.

All top covers shall be Stainless Steel Grating with Cockroach Traps from Chilly or equal.

2.2.5 FLOOR CLEAN OUTS

Floor clean outs shall be provided in toilet blocks for Soil and Waste Drainage Systems, as detailed in the drawing, with uPVC pipe work and female threaded sockets. Clean out Covers shall be with Heavy Duty Stainless Steel Plugs having male threads and with suitable insertion keys for opening.

2.2.6.1 GRATING FOR DRAINAGE CHANENL FOR KITCHEN

The Grating required for Drainage Channel for Kitchen tentatively shall be Light Duty Ductile Iron Gratings, as per EN-124, of size 300mm. wide x 600mm. long, weighing, 12Kg, each, from reputed manufacturer.

The item, quantity, overall sizes etc. shown in the drawings and B.O.Q. are tentative only and shall change as per final requirement and design of the proposed kitchen

Trap for above trays shall be of Cast Iron with deep seal.

2.2.6.2 GULLY TRAPS

Gully Traps shall be of PVC construction, with **Deep Seal and** with 100mm. inlet and outlet. The Gully Traps shall be kept in masonry inspection chambers.

2.2.6.3 PIPES FOR RAIN WATER HARVEST SYSTEM.

Rain Water Down Take (Vertical) Pipe Work shall be with Ring Fit uPVC (SWR), with rubber gaskets over sockets, conforming to IS 13592: 1992, Type-A. Fittings shall be SWR Moulded fittings, conforming to IS 14735: 1999, with ring seal adaptors over sockets, conforming to IS 5382. Approved lubricant is advisable for fixing/joining pipes and fittings.

Rain Water Pipe Work, concealed in ceiling void and Under Ground Pipe work shall be of uPVC, conforming to IS 4985: 2000, with working pressure 6Kg./Cm2. Fittings shall be injection moulded fittings, conforming to IS 7834: 1987. Fixing shall be with heavy duty uPVC solvent cement/adhesive, from the same manufactuturer, for pipes and fittings.

All jointing shall be strictly as per manufacturers instructions. Curing time for adhesive joints shall be 24 hours and pipe work will be permitted to use only after 24 hours.

Rain Khurra (Rain Water Outlet) shall be in Cast Iron/Aluminium Construction, complete with Dome, Gratings, S. S. Screws etc. suitable for 110mm. and 160mm. down pipes.

2.2.7 WATER SUPPLY SYSTEM.

The Source of Domestic Water for the total premises shall be KWA Supply and thro. Rain Water harvesting.

Rain / Storm Water, captured from the total premises is collected in 3 reservoirs and treated by a water treatment plant. This treated water will be stored in underground tank will be pumped to the overhead water tank. The KWA water collected in underground tank also pumped to the OHT.

From the overhead tank water will be distributed to various buildings /location in the premises. (All are ongoing project.)

This supplied water will be collected in a 75KL. Capacity Underground Water Tank, close to the building (by overflow from adjacent Fire Water Storage Tank). The water stored in the underground tank shall be lifted /transferred, by hydro-pneumatic pumping system, to 2 Sets of Overhead/ Roof Tanks, each of Capacity:

20KL (these tanks will be clustered with fire water tank of capacity:20KL, each.)

From above overhead water tank domestic water will be supplied, by gravity flow, to wash basins, health faucets, taps, water coolers, kitchen sink etc. in toilet blocks, canteen and kitchen,

The inlet pressure for domestic & drinking water supply to toilet blocks, canteen and kitchen shall be regulated between 1.5 to 2.5 Bar for controlling the water flow through concerned fixtures and hence to achieve the reduction in water usage to required level.

The source of Raw Water for flushing and landscaping irrigation shall be the treated water from Sewage Treatment Plant, proposed for the project.

The STP Treated Water stored in the concerned underground tank shall be distributed to EWC Cisterns and Urinal Flushing Units, by a properly designed Hydro-Pneumatic Pressure Booster Raw Water pump Set.

The inlet pressure for raw water supply to flushing cisterns / units, in toilet blocks, shall be regulated between 1.5 to 2.5 Bar for controlling the water flow through concerned fixtures and hence to achieve the reduction in water usage to required level.

The Raw Water Pumping System shall be tuned to achieve above pressure regulation.

The actual inlet pressure required for to toilets, pantries and kitchen and to concerned fixtures/tap fittings are to be redesigned, as per final requirement, before installations.

Pressure reducing stations, if required, also to be included in domestic and raw water distribution network.

The system contractor has to submit the re-design of pressure regulations, to the approval of the system consultant, before installations.

All materials shall be new and of the best quality conforming to specifications. Contractor should study the water supply system drawings and site plan drawings thoughrly, for getting a clear view of the proposed system.

All Pipes shall be cut, cleaned and jointed (pipes together and pipes and fittings) in a neat manner, as per manufacturers instructions and to the approval of consultants.

All pipes shall be fixed in position, at site, as per details in the approved working drawings, with specified route and spacing. The spacing for pipe supports shall be

as detailed in the drawings.

Pipe work shall be fixed in a neat manner, as detailed in the approved working drawings, as to provide easy accessibility for repair and maintenance and shall not cause obstruction in shafts, passages etc. The vertical risers shall be parallel to walls and columns and shall be straight and plumb.

Isolating Valves and other appurtenances shall be installed at easily accessible locations with access doors/manhole covers etc. for emergency operation, repairs and maintenance

Rates for Pipes will be measured in unit rate per linear meters and inclusive of all fittings, such as Elbows, Tees, Reducers, Sockets, Flanges, Unions, Pipe Supports, Clamps, Expansion Joints, Bolts, washers, Nuts etc, as per requirement and site conditions.

The item "Pipe Work" shall be inclusive of supply, fix at site (concealed in walls, RCC structure, ceiling voids etc. and exposed, horizontally and vertically, on walls, roof slabs, in ducts etc. and laying in underground, with appropriate pipe clamps, pipe supports, hanging supports, fasteners, concrete supports, thrust blocks etc), pressure testing, anti corrosive and weatherproof protective coatings and encasing/wrapping, as per requirements, and commissioning.

The rate for concealed pipe work shall be inclusive of cutting, chasing drilling etc. through all types of walls /floors and finishing for all services crossings, including sealing, frame works, fire proofing with approved fire resistant materials, providing sleeve,

cover plates, making good structure and finishes to an approved standard etc. in a neat manner to the approval of Engineer – in –charge.

Exposed pipe work shall be fixed on walls, roof slabs, columns etc. with approved G.I. Supporting

Systems consisting of slotted rails, U-clamps, saddle clamps, fastners, hanging rods, bolts nuts etc, as per requirement, in a neat manner, to the approval of Engineer – in –charge

Contractor shall provide all sleeves, openings, hangers, and inserts during the construction. He shall provide the necessary information to the building contractor for making such provisions in the structure necessary. All damages shall be made good to restore the surfaces.

All the Internal Water Supply Pipe Work, Cold and Hot, shall be hydrostatically pressure tested, in parts or as a whole, with treated water to 10.0 Kg/Cm2, at least for 2 hours or to 7.5 Kg/Cm2 for a period of 24 hours, as instructed by

the Engineer-in - charge and as and when demanded by the Engineer - in Charge / System Consultant.

The Pipe Work, as a whole, shall be once again pressure tested to 7.5 Kg/Cm2 for a minimum period of 24 hours, before commissioning of the total Systems.

The total Systems including equipment and complete water distribution pipeline network shall be tested to the approval of Engineer – in – charge and System Consultant.

On completion, the entire water supply system to be disinfected before handing over. First all the water storage tanks, complete pipe work, sanitary fixtures, cisterns etc. shall be filled with clean water and thoroughly flushed out. After that all storage tanks shall fill with clean water and disinfecting chemicals such as fresh bleaching powder at the rate of 50mg/Ltr. Bleaching powder shall be added gradually, while the tanks are being filled to ensure thorough mixing. (For ordinary bleaching powder the above dosage shall goes up to 150mg/Ltr. and for other branded disinfecting agents dosage shall be as per manufacturers specifications) The powder shall made to creamy with water before adding to the water storage tanks. When the Storage tanks are full, the filling and mixing with chemicals can stop. Then gradually start the pumps, open valves, cisterns etc and allow the water to flow gradually through entire pipe net work and fixtures and flush out thoroughly. If required repeat the procedure once again with increasing the dosage of infecting agent. The total system should be thoroughly flushed out with clean water before usage. The entire disinfections process shall be to the approval of the Engineer – in – charge and System Consultant.

The Rates for water supply pipe work shall be inclusive disinfection of water supply pipe work. Any extra claim in this respect shall not be entrained.

All Cutting, chasing and drilled/cut holes in the floor slabs for fixing sanitary fixtures, accessories, floor traps, concealed traps and water supply connections for the same should be made thoroughly water tight, along with the floor slab and sunken area, by advanced and latest technology for water proofing.

For details of external work, see Spec 2.7

2.3.1.1 PIPES FOR COLD WATER SUPPLY SYSTEM:

All Internal Cold Water Supply Pipe Work shall be with High Pressure uPVC Pipes, Sch. 40 (ASTM D 1785) and Sch. 80 (ASTM D 2467) Fittings. The Solvent Cement shall be one step for pressure pipes and fittings from the same manufacturer.

All the out let points, for concealed pipe work in Toilets, Kitchen and Pantries, for fixing angle valves, taps etc, shall be with 15mm. brass female threaded end fittings, from the same manufacturer.

All the Pipes and fittings shall be cut, jointed and fixed as per manufacturer's instructions. Curing time for adhesive joints shall be 24 hours and pipe work will be permitted to use only after 24 hours.

2.3.1.2 PIPES FOR HOT WATER SUPPLY SYSTEM:

All Hot Water Supply Pipe Work shall be with CPVC PIPES, 4120, SDR 11, as per ASTM D 2846 and with Heavy Duty Solvent Welded CPVC Fittings. The Solvent Cement shall conform to the Standards of ASTM – 493.

All the out let points, for concealed pipe work in Toilets, Kitchen and Pantries, for fixing angle valves, taps etc, shall be with 15mm. brass female threaded end fittings, from the same manufacturer.

The rate for hot water pipe work, concealed in wall, shall be inclusive of supplying and fixing 6mm. thick flexible closed cell thermal insulation.

All the Pipes and fittings shall be cut, jointed and fixed as per manufacturer's instructions. Curing time for adhesive joints shall be 24 hours and pipe work will be permitted to use only after 24 hours.

2.4 WATER SUPPLY PUMPS AND ACCESSORIES.

The proposed head(s) for Domestic and Raw Water Transfer /Distribution pumps, as in the Tender Schedule shall be as per initial design and shall vary as per final total length of transfer pipes/pumping lines and fittings. The contractor has to submit calculations for final head(s) required/arrived, for various pumps, for approval before ordering for the pumps.

Control Panels for all water transfer pumps shall be with necessary volt free contacts and other facilities, for each pump, for integrating with IBMS, proposed for the project.

2.4.1 Domestic / Treated Water Transfer Pump Set

The Pump Set shall be Hydro Pneumatic, Factory Assembled Packaged Pump Set, complete with;

- 3 Pump System with One Working, One Assist and 1 Stand by Pumps
- Capacity of Pump: 10M3 / Hr @ 50 Mtr. Head, each,
- Driving Motor: 2.2 kW, 3 Phase, each, 2900 rpm, TEFC, IE2
- Contrail Panel & Drive: Automatic, Microprocessor Based; VFD Drive.
- Complete with Suction & Delivery Manifolds, Control Valves, Pressure Gauge, Pressure Switch etc. 200Ltr. Diaphragm Pressure Vessel etc, all on a common base frame.

The price for pump set shall be inclusive of all connected electrical work.

All the Pump shall be Vertical Multistage Centrifugal with following components and details.

Bottom casing, outer casing cover & top casing cover: SS 316

- Suction, Delivery Casing; Cast Iron
- Impeller: SS 316
- Shaft: SS 316
- Mechanical Seal
- Dynamically balanced rotating parts.
- Non overloading power characteristic for safety of motor.
- Replaceable wearing parts.

2.4.2 Raw / Flushing Water Distribution Pump Set.

The Pump Set shall be Hydro Pneumatic, Pressure Booster Factory Assembled Packaged Pump Set, complete with;

- 3 Pump System with One Working, One Assist and 1 Stand by Pumps
- Capacity of Pump: 20M3 / Hr @ 55 Mtr. Head, each,
- Driving Motor: 5.5 kW, 3 Phase, each, 2900 rpm, TEFC, IE2
- Contrail Panel & Drive: Automatic, Microprocessor Based; VFD Drive.
- Complete with Suction & Delivery Manifolds, Control Valves, Pressure Gauge, Pressure Switch etc. 200Ltr. Diaphragm Pressure Vessel etc, all on a common base frame.

The price for pump set shall be inclusive of all connected electrical work.

Pump shall be Vertical Multistage Centrifugal with following components and details.

Bottom casing, outer casing cover & top casing cover: SS 316

- Suction, Delivery Casing; Cast Iron
- Impeller: SS 316
- Shaft: SS 316
- Mechanical Seal
- Dynamically balanced rotating parts.
- Non overloading power characteristic for safety of motor.
- Replaceable wearing parts.

2.5 ELECTRIC WATER HETAER.

Electric Water Heater shall be of non-pressure type, with ISI mark and with following features.

- Rust proof body with polypropylene or equal.
- Stainless steel inner container.
- Multi function safety valve for high pressure withstanding capacity.
- PUF insulation for maximum energy saving.
- Heating element with high efficiency.
- Energy labeling: energy saving up to 40%
- Thermal cutout.
- Temperature regulator.

2.6 VALVES AND ACCESSORIES:

2.6.1 Isolating Valves:

Isolating valves for water supply lines up to 65mm. shall be Gun Metal Gate Valve, conforming to IS: 778, with following features.

- Type : Screwed in Bonnet, in side Screw
- Pressure Rating : PN 20
- Body : Gun Metal
- Stem : Bronze, Non Rising
- Wedge : Solid, Bonze
- End Details : Screwed
- Wheel : Cast Iron

Alternatively; Ball Valves ca also be used without any cost complications,
Ball Valves shall be conforming to IS: 9890 with following features.

- Pressure Rating : PN 20
- Body : Foged Brass
- Ball : Stainless Steel 316
- Seats : PTFE/Acetal
- Handle : Stainless Steel 316/Cadmium Plated Steel.

Isolating valves for water supply lines above 65mm. size shall be Butterfly Valves.

Butterfly valves shall be with integrally moulded seat to the body and conforming to BS 5155/IS 13095 with following features.

- Pressure Rating : PN 16
- Body : Cast Iron to BS 1452 or Equal.
- Disc : Cast Iron to BS 1452 with Nylon coating/SG Iron to BS 2789
- Seat : Black Nitrile

- Shaft : Carbon Steel (EN 8 or ASI 410)
- Bearing : PTFE/Acetal.

2.6.2 Sluice Valve.

Sluice Valve shall be of non-rising spindle, conforming to IS: 14846, with flanges and following features.

- Pressure Rating : PN 16
- Body : Cast Iron
- Wedge : Leaded Tin Bronze to IS: 318 Gr. LTB-2
- Rings : Leaded Tin Bronze to IS: 318 Gr. LTB-2
- Spindle : Leaded Tin Bronze to IS: 318 Gr. LTB-2//Stainless Steel to IS: 6603 Gr. 12Cr12
- Stem : Non Rising
- Stem Nut : Leaded Tin Bronze to IS: 318 Gr. LTB-2

Sluice Valve shall be with spindle only at top, 'fabricated key' for operation from ground level, complete with cap for spindle, extension rod, handle/wheel at top etc, to the approval of Consultant and with companion flanges, nuts, bolts etc.

2.6.3 Non Return Valves:

Non Return Valves for fire lines shall be hydraulically engineered, tight shut off, self acting, bronze swing type check valves, conforming to IS 13095 with following features.

- Pressure Rating : PN 16
- Body : Gunmetal
- Disc : Gunmetal
- Hing Pin : Gun metal
- Seat : EPDM or equal
- End Facing : Plain

2.6.4 Pressure Reducing Stations.

Pressure Reducing Station shall be complete with Pressure Reducing Valve and Pressure Gauges with siphon connections on upstream and downstream of pressure reducing valve.

Pressure reducing valve shall be with pressure regulator, flanged/female screwed ends, non jamming stainless steel bolts, provision for 1/4" pressure gauge connection on both ends, all other accessories and be of trouble free and noise

free working. It shall conform to AFNOR NF 43-006 and BS6765, and with following features.

- Maximum Inlet Pressure : 25 Bar.
- Outlet Pressure : 1 to 4.0 Bar.
- Material of Construction : Bronze
- Diaphragm : Food Grade Rubber (EPDM)
- Maximum Water Temperature : 100 Degree C

2.6.5 Y-Strainer

Y-Strainer shall be with Bronze Body, flanged/female screwed connections on both ends and with screen, flanged blow off cover, gasket and plug. The Screen shall be Stainless Steel on machined seat to ensure a perfect fit for the removable S.S. Screen. The Strainer shall be with following features.

- Pressure Rating : 200psi at 150^0 d F
- Body, Cover, Plug: Bronze
- Flange : ANSI
- Screen : Stainless Steel, Heavy gauge perforated, 1/8 to 3/64", Opening - 0.125"

2.6.6 Foot Valve

Foot Valve Shall be Ball Type with following features:

- Pressure Rating : PN10
- Body : Cast Iron
- Strainer : Cast Iron
- Ball : Nitrile Reinforced Rubber
- Seal Ring : Nitrile Reinforced Rubber
- Fastener : Carbon Steel
- Adaptor : Cast Iron
- End Details : Screwed

2.6.7 Heavy Duty Ball Valve

Ball Valve shall be Heavy Duty as per IS 1703:2000, with following features:

- Working Pressure : 25 Bar.
- Stem / Lever : Bronze
- Adapter : Bronze

- Ball : ABS
- Seal Ring : Nitrile Reinforced Rubber
- End Details : Screwed

2.6.8 Air Release Valve

The body of air release valve shall be made of high strength composite materials and all operating parts should be made of specially selected corrosion resistant materials. Base material shall be nylon or stainless steel. The Air Release Valve shall be with following features.

- Pressure Rating : 3 - 250 psi.
- Orifice Area : 0.014 sq.in
- Working Temperature : 60^{O} C
- Body, Base, Stem : NSF 61 Certified Reinforced Nylon
- Discharge Outlet : NSF 61 Certified Polypropylene
- Rolling Seal : NSF E.P.D.M
- Float : NSF 61 Certified Foamed Polypropylene
- O-Ring : NSF 61 Certified NBR 70
- Strainer : Nylon

2.7 EXTERNAL AND CIVIL WORKS:

2.7.1 UNDER GROUND PIPE WORK

Before starting the excavation for trenches, for under ground pipe work, permission shall be obtained from the project engineer and concerned authorities, if required.

Rates for trenches for under ground drainage pipe work shall be inclusive of excavation in all kinds of soil, to required depth, back filling in layers, compacting to required standards and disposal of surplus earth and waste materials out of the construction site.

All underground uPVC pipe works shall be laid at a minimum depth of 1.0 Mtr. below ground level. In special cases, with approval from consultant and project engineer, minimum depth shall be reduced to 60cm. below ground level in non-traffic areas.

All underground uPVC pipe work shall be laid in trenches on sand bed, free of stones and other objects, to a minimum bedding of 15cm. An overall covering with sand shall be provided such a way to have a minimum cover of 30cm. above the pipes.

Thrust blocks, of suitable dimensions shall be provided to under ground uPVC pipes at bottom points of vertical stacks and at junctions, where ever change of

direction required. Also concrete supports and anchors shall be fixed as per requirement and site conditions.

Coloured Plastic foil warning grids/tapes shall be provided above all under ground pipe work.

For traffic areas, all under ground pipe work shall be protected with higher dimension PVC sleeves, if required, and plain cement concrete encasement, 1:5:10 to a minimum covering of 10cm. all around the Pipe/Sleeve. Coloured Plastic foils warning grids also to be provided.

Piping shall be kept free of earth, debris, dust, other foreign matters, insects etc. and every pipe shall be cleaned after installation and subjected to inspection of the consultant at any time during construction.

No pipe shall be laid under unsuitable conditions.

2.7.2 DRAINAGE WORK:

Setting out for external services shall be done as per relevant rules, regulations and practices.

Slopes and inverts shall be as per approved drawings and site conditions.

All under ground drainage lines shall be laid in trenches, in position, at required depth with specified gradients and fixed with suitable concrete/masonary thrust blocks, anchors, supports etc. as detailed in above section.

As far as possible the Crown Levels of Pipes shall be matching when different sizes of horizontal drainage pipes are jointed. This shall be applicable for connections in manholes also.

Sewer lines shall be inclusive of earthwork, pipelines, manholes, drop connections and connections to the septic tanks and soak pits.

Drop connections shall be given to sewage manhole when the drops exceed 60cm. and benching shall be done at the bottom.

Rainwater drainage shall be inclusive of earthwork, pipelines, manholes, catch basins and connections to the disposal trench or existing municipal storm water drain.

All the underground soil, waste and rain water pipe work shall be fully tested for water tightness by means of water pressure maintained for not less than 24 hours.

The rates for underground pipe work shall be inclusive of supply, fix pipes and fittings and laying in under ground, in position with proper slopes and fixing with concrete/masonary thrust blocks and supports wherever required, water testing, and commissioning.

Recommended width of trench shall be 55cms at the bottom and no additional payment is admissible for widths grater than this.

Excavation of trenches of required width for pipes, include excavation for sockets, depth up to 1.5 m, including getting out the excavated materials, returning the soil as required in layers not exceeding 20 cm in depth, including consolidating each deposited layers by ramming, watering etc., stacking serviceable material for measurements and disposal of unserviceable material as directed, within a lead of 50 Mtr.

Excavation for trenches shall be measured in Mtr. as per DSR: 14

Excavation of trenches with depth exceeding 1.5 Mtr. shall be measured separately as per DSR:14

Manholes shall of specified type, size and with specified invert levels. The sizes given in the drawings are internal sizes of the chambers. The Manholes shall be constructed, as per Central PWD and NBC of India with following details.

Construction of brick masonry manhole shall be in cement mortar 1:4 (1 cement: 4 coarse sand), in side cement plaster 12 mm thick with cement mortar 1:3 (1 B994 cement: 3 coarse sand) finished with a floating coat of neat cement, foundation concrete 1:3:6 mix (1 cement: 3 coarse sand: 6 graded stone aggregate 40 mm nominal size), and making necessary channel in cement concrete 1:2:4 (1 cement : 2 coarse sand : 4 graded stone aggregate 20 mm nominal size) finished with a floating coat of neat cement, all complete as per standard design :

Man holes/Inspection Chamber covers shall be of Cast Iron, as per IS: 1726-1967 or Ductile Iron to EN-124, with lifting hooks and with air tight Cast Iron frame, embedded in concrete, over the manholes. All the manholes shall be with double seal. Manhole covers shall be of Heavy Duty for traffic area and of Medium Duty for other areas.

Gully Trap chambers shall be with specified internal sizes and constructed with bed concrete, brickwork, plastering and with covers, as per specifications for manholes.

The rates for manholes and gully trap chambers shall be inclusive of excavation, construction, curing, cover fixing, testing, back filling, compacting, removal of surplus earth and waste and commissioning.

Septic Tanks, Soak Pits, Pump Room etc. shall be constructed as per specification for Civil/Structural work for the project. Powder coated Cast Iron steps shall be provided for Septic Tanks.

The Plumbing Contractor shall fix in position, with proper alignment, Heavy Duty uPVC Puddle Flanges, of required sizes, on the formwork during casting of the Septic Tanks, for making the inlets, and outlets.

All the Septic tanks including its connections shall made leak proof by advanced and latest technology for waterproofing.

2.7.3 SOLID INTERCEPTOR.

Solid Interceptor shall be for removing solids in Kitchen Waste Water and shall act as an integral part of Oil / Grease interceptor, proposed for the Kitchen,

The Equipment shall be of Approved Make and Model, with following features.

- One piece moulded tank with engineered thermoplastics.
- With slotted baffles and basket for easy removal of solids
- Reinforced Polypropylene top cover, capable holding 220Kg, with silicone rubber seat.
- Suitable for high flow rate up to 3.2 LPS even when the equipment is loaded with 50% of its solid holding capacity.
- With maximum operation temperature of 104^{0} C.

2.7.4 OIL / GREASE INTERCEPTOR.

The Oil / Grease Interceptor shall be for removing oil and grease in Kitchen Waste Water and shall of Approved Make and Model, with following features.

- One piece moulded tank with engineered thermoplastics.
- Removable Polypropylene Baffles
- Reinforced Polypropylene top cover, capable holding 220Kg, with rubber gasket.
- Diffuse baffle.
- Suitable for high flow rate up to 3.2 LPS.
- With maximum operation temperature of 104^{0} C.

2.7.5 WATER SUPPLY WORK.

All Under Ground Cold Water Services Pipe Work shall be with High Pressure uPVC Pipes, Sch. 80 (ASTM D 1785) and high pressure fittings, Sch. 80 (ASTM D 2467) such as bend, tees, couplers, reducers, unions, flanges, male and female threaded couplings, adaptors, sockets, end plugs etc. The Solvent Cement shall be one step for pressure pipes and fittings, from the same manufacturer.

All underground water supply lines shall be laid in trenches, in position, at required depth with a suitable slope to facilitate for complete draining during maintenance and fixed with suitable concrete/masonary thrust blocks, anchors, supports etc. as detailed in above section.

Recommended width of trench shall be 30cms at the bottom and no additional payment is admissible for widths greater than this.

Water Supply lines includes earthwork, pipelines, valves, valve chambers and final connection to water pump, water tanks and other equipment and sources of water points, as detailed in the drawings.

All the underground pipe work shall be pressure tested, as a whole, with water to 11.0 Kg/Cm2 at least for 2 hours or to 8.5 Kg / Cm2 for a period of 24 hours, as instructed by the Engineer-in – charge and as and when demanded by the Engineer – in Charge/ System Consultant.

The rates for underground pipe work shall be inclusive of supply, fix pipes and fittings and laying in under ground, in position with slopes and fixing with concrete/masonary thrust blocks and supports wherever required, pressure testing, and commissioning.

Trenches shall be measured per linear meter. Valve chambers shall be measured as a lump sum basis.

Valve chambers shall be of specified type, internal sizes and depth and shall be constructed with bed concrete, brickwork, plastering and with covers, as per relevant rules of Central & Kerala PWD and NBC of India.

Valve Chamber covers shall be of Cast Iron, as per IS: 1726-1967 or Ductile Iron to EN-124, with lifting hooks and with air tight Cast Iron frame, embedded in concrete, over the valve chambers. Valve chamber covers shall be of Heavy Duty for traffic area and of Light Duty for other areas.

Valves shall be installed with stem upright and handle at top in case of ball valve.

The rates for Valve chambers shall be inclusive of excavation, construction, curing, cover fixing, testing, back filling, compacting, removal of surplus earth and waste and commissioning.

Water tanks shall be part of the civil contract and shall be constructed as per specification for Civil/Structural work for the project. Powder coated Cast Iron steps shall be provided for water tanks.

The Plumbing Contractor shall fix in position, with proper alignment, Heavy Duty UPVC Puddle

Flanges, of required sizes, on the form work during casting of the under ground and roof water tanks, for making the inlets, outlets and drain points.

All the water tanks including its connections shall made leak proof by advanced and latest technology for waterproofing.

2.7.6 BACK FLOW PREVENTING DEVISE.

The Backflow Preventing Devise shall be of PVC Construction with Non Return Valve.

The flap will immediately shut when backflow occurs and suitable for low water conditions.

2.7.7 WATER FLOW METER

The Water Flow Meter shall be as per IS: 2373 and tested by Municipal Board and to the approval of Kerala Water Authority, complete with bolts, nuts, rubber insertions etc. and all necessary accessories etc.

2.8 M.S. PIPE SUPPORTING SYSTEM FOR PIPE WORK. (Optional Item, if required only)

M.S. Pipe Supporting System, if required, shall be fabricated from M.S. Sections with base plates, expansion/anchor bolts etc, as per requirement. The rate for M.S. Supporting System shall be inclusive of surface preparation and paint protection, as detailed below.

2.8.1 SURFACE PREPARATION

Following steps shall be done for the proper surface preparation of M.S. Sections to receive protective painting system.

- Initial Cleaning to remove oil, grease, dust and any other foreign matters and loose particles.
- Thorough cleaning, preferably with mechanical buffing to remove rust and factory coatings, if any.
- Final cleaning with cotton wastes and approved thinner to remove the rust powder and any balance particles.

2.8.2 ANTI CORROSIVE PAINT PROTECTION SYSTEM

Following Paint protection Systems shall be done for M.S. Supporting System.

- The cleaned M.S. Sections shall be immediately coated with one coat of approved Zinc Rich Epoxy Metal Primer to a DFT recommended by the Paint Manufacturer. (Avoid areas where cutting and welding are required).
- After fabrication and erection the affected area of all M.S. Sections should be immediately cleaned properly to remove dust, rest, welding flex and any other foreign matters, preferably by mechanical buffing, and apply one touch up coat of Zinc Epoxy Rich Primer.
- The total supporting system, after fabrication and erection, shall be treated with 2nd coat of Zinc Rich Epoxy Primer to a DFT recommended by the manufacturer.
- The supporting system shall be finally protected with 2 coats of approved Enamel Paint.

All the protective paints, selected, shall be compatible, each other.

All above protection system shall be to the approval of consultant and as per paint manufacturer's recommendations. The interval between successive paint coatings shall be 24 to 48 hours (or as per recommendation of the manufacturer). For applying the next coat after 48 hours or a long time, the pre painted surface has to be cleaned completely with suitable size emery paper to clean and roughening the surface to receive the next coating. After removal of dust and loose particles, with cotton waste and light thinner, next paint coating can be applied.

Technical Specification- Electrical Installation Work

LIST OF IS: SPECIFICATIONS FOR ELECTRICAL INSTALLATION WORK

The following specifications will apply under all circumstances to the equipment to be supplied and installed against this Contract. It is to be ensured that the Contractor shall obtain for himself at his own expense and on his own responsibility all the information which may be necessary for the purpose of submitting the tender and for entering into a contract, keeping in view the specifications of installation and inspection of site etc.,

INDIAN STANDARD HT EQUIPMENT SPECIFICATIONS

1. HT cable	:	IS 7098 Latest
2. 11KV Load Break Switch	:	IS 265 / IS 9920
3. 11KV VCB panel	:	IS 13118 / IS 3427
IEC60056 / IEC298		
4. Distribution transformer	:	IS 2026
5. Metal enclosed switch gear and control gear for voltage above 1000V, but not exceeding 11000V.	:	IS-3427 / BS-162

INDIAN STANDARD LT EQUIPMENT SPECIFICATIONS

1.	LT Air Circuit Breakers	:	IS 2516 - Latest PART I & II Section – I, 8828 / BS- 5311, 4752
2.	Fuse switch units and switch Fuse units not exceeding 1000V AC or 1200 V DC	:	IS 4064 Latest/ BS-5419/IEC-408
3.	Switch gear Bus bar	:	IS 375 Latest
4.	H R C fuse Links	:	IS 2208 Latest
5.	Distribution Boards	:	IS 2675 Latest
6.	Enclosures for low voltage Switch gears	:	IS 2147
7.	P V C cables (Heavy Duty)	:	IS 1554 Latest
8.	P V C cables (Working Voltage up to and including 1100V)	:	IS 694 Latest

9.	Tabular Fluorescent lamps	:	IS 2418 Latest
10.	Tungsten filament lamps	:	IS 415 Latest
11.	Ceiling fan	:	IS 374 Latest
12.	Flood light	:	IS 1947 Latest
13.	Industrial light fittings	:	IS 1771 Latest
14.	Water proof electrical fittings	:	IS 3553 Latest
15.	Steel boxes for enclosure of	:	IS 5133 Latest
16.	Electrical accessories		

- Fittings for rigid steel conduit : IS 2667 Latest
- Mild steel conduit for Electrical wiring : IS 653 Latest
- Accessories for rigid steel Conduit for electrical wiring :IS 3837 Latest
- Switch socket outlets : IS 4615 Latest
- Three pin plug& socket outlet : IS 1293 Latest
- Switches for domestic and Similar Purposes : IS 3854 Latest
- Call bell and buzzers : IS 2268 Latest
- Earthing : IS 3043 Latest
- Electrical wiring installation : IS 732 Latest

17.	Switch gear	:	IS 3072 Latest
18.	Lighting protection	:	IS 2309 Latest
19.	HT Cable	:	IS 7098 Latest
20.	Power transformer	:	IS 1886 Latest

21.	Current Transformer	:	IS 2705 Latest
22.	MCCB	:	IS 2516 part I & II/ Sector I Latest
23.	Relays	:	IS 3231 Latest
24.	Indicating Instruments	:	IS 1248 Latest
25.	Auxiliary contactors	:	IS 2959 Latest
26.	Power factor correction		
27.	Capacitors	:	IS 2834 Latest or
28.	PVC / Metal conduiting	:	IS 9357 Latest Part I, 2,3 & 4
29.	Bus-bar support insulators	:	IS 2544 Latest
30.	Voltage Transformer	:	IS-3156/BS-3941IEC-44,186
31.	Electrical relays	:	IS-3231, 3842
32.	Contactors for voltage not exceeding 1000V AC or 1200V DC Control Switches	:	IS-6875/BS-4794/IEC-377
33.	High Voltage fuse	:	IS-9385/BS-2692/IEC-269
34.	Low Voltage fuse	:	IS-1248/BS-89/IEC-51
35.	Indicating instruments A.C. electricity Meters IEC-of induction type 45,211:		IS-722, 8530 / BS-5685 /
36.	Porcelain post insulators for system with nominal voltages greater than 1000volts.:		IS-2544
37.	Resistance wire, tapes and strips for heating elements	:	IS-3725
38.	Wrought aluminium and aluminium alloy bars, rods, tubes and sections for electrical purposes.	:	IS-5082
39.	Toggle switches	:	IS-3452 / BS-3676

40. Metal enclosed switchgear and control gear for voltage above 1000V, but not Exceeding 11000V : IS-3427 / BS-162

41. General requirement for switchgear and control gear for voltage not exceeding 1000 volts : IS-4237/BS-5486/IEC-439

42. Degree of protection provided by enclosures for low voltage Switchgears and control gear : IS-2147/IEC-144

43. Dimensions for panel mounted indicating and recording electrical instrument : IS-2419

44. Marking and arrangement for switch-gear, bus-bars, main connection and auxiliary wiring. : IS-375

45. Code of practice for selection, Installations and maintenance of fuses. : IS-10118

TECHNICAL SPECIFICATION FOR 500 KVA, 11KV/433V DISTRIBUTION TRANSFORMER

1.1 INTRODUCTION

This specification covers the design, manufacture, shop testing, transport and delivery of the transformer and associated accessories at the site and commissioning of the transformer.

The equipment shall be manufactured in the manner set out in this specification or where not set out, to the reasonable satisfaction of the purchaser.

All fittings and accessories or apparatus which may have not been specifically mentioned below, but which are necessary and essential for the efficient working of the equipment, shall be deemed to be included in the contract.

1.2 STANDARDS

≫ The design, material, construction, manufacture, inspection, testing and performance of the transformer shall comply with all currently applicable statues, regulations and safety codes.

≫ Except otherwise stated, the transformer and associated accessories shall conform in all respects to the latest issues of standards as given below:

1. Power transformer	:	IS 2026
2. Fittings and accessories for Power transformer	:	IS 3639
3. Bushings (Alternating voltages Above 1000 V)	:	IS 2099
4. Bushing current transformers	:	IS 2075
5. Insulating oil	:	IS 335
6. Classification of insulating materials	:	IS 1271
7. Current transformer	:	IS 2705 (Ptr. I & III)
8. Guide for loading of oil immersed Power transformer	:	IS 6600
9. Porcelain bushing for transformers	:	IS 4527
10. Gas operated relays	:	IS 3637
11. Code of practice for selection, Installation and maintenance Of Transformer	:	IS 10028

≫ Wherever the relevant ISS are not applicable, specifications of CBIP/BSS/IEC may be adopted.

≫ Deviations if any from the specification / standards shall clearly explained.

≫ The electrical installation shall meet the requirement Indian Electricity Act 1910. Electricity (Supply) Act 1948 & Indian Electricity Rules 1956 as amended upto date.

1.3 INSULATION

The primary winding of the transformers shall be suitable for highest system voltage of 12 KV for 11KV primary voltage and shall withstand power frequency test voltage as per table 2 of IS 2026 / 1981 part (III)).

Impulse : HV Side : 75 KV

Power frequency : HV Side : 28 KV rms

LV Side : 3 KV rms

The inter-turns and end-turns of the HV & LV windings shall be insulated for protection against surges and transients.

The insulation shall be of class "H" or higher confirming to IS 1271 / 1958.

1.4 TEMPERATURE RISE

≫ The transformer shall be capable of operating continuously at full rating without exceeding the temperature limits specified below:

≫ Temperature rise of top oil measured by Thermometer, for ONAN cooling : 50 ° C

≫ Temperature risk of winding measured by Resistance, for ONAN cooling : 55 ° C

≫ The ambient temperature (maximum) Of cooling medium (Air) is : 50 ° C

Room Ventilator requirements are to be intimated along with the offer.

1.5 DUTY REQUIREMENTS

≫ The transformer and all its accessories like current transformers etc. shall be designed to withstand without injury, the thermal and mechanical effects of any external short circuit to earth and of short circuits at the terminals of any winding for a period of 2 seconds. Transformer shall be capable of withstanding thermal and mechanical stresses caused by symmetrical or asymmetrical faults on any winding.

≫ The transformer shall be capable of being loaded in accordance with IS: 6600. There shall be no limitation imposed by bushings, tap-changer, etc.

≫ The overload capacity of the transformer and their emergency short time rating called for in schedule shall be furnished.

≫ The transformer shall be suitable for continuous operation with a frequency variation of +5% without exceeding the specified temperature rise.

≫ The transformer shall be capable of being operated without danger on any tapping at the rated KVA with voltage variation of +10% corresponding to the voltage of that tapping and at the same time with a frequency of 5% below normal.

≫ Similar ratio transformers shall operate satisfactorily in parallel with each other.

1.6 Radio interference and Noise level:

≫ The transformer shall be designed with particular attention to the suppression of maximum harmonic voltages, especially the third and fifth, so as to minimize interference with communication circuits.

≫ The Noise-level, when energized at normal voltage and frequency, shall not exceed, when measured under standard conditions the value specified by NEMA.

≫ The maximum flux density in any part of the core and yokes at normal voltage and frequency shall be such that the flux density under over voltage conditions shall not exceed the maximum permissible values for the type of core and yoke material used. The type of material and values of flux sensate in the core/yoke for the 100%, 110%, 125% and 140% and the hysteristis characteristic curves shall be included in the bid and shall be subject to the purchaser's approval.

≫ The transformers shall be designed for the following overfluxing withstand capability:

110%	-	Continuous
125%	-	for 1 minute
140%	-	for 5 seconds

≫ The transformers shall operate below the knee of the saturation curve at 110% voltage to preclude Ferro-resonance and non-linear oscillations.

≫ Transformers shall be capable of operating under natural cooled condition to the specified capacity. Transformers shall be capable of operating continuously in accordance with the application standard loading guide at their rated KVA and at any of the specified voltage ratios.

1.7 IMPEDANCES

≫ The percentage impedance voltage at principal tapping on the ratio primary/secondary KVA base shall be as per technical data enclosed. The permitted tolerance on this value is 5%.

≫ To achieve the above percentage impedance values no reactor either inside or outside the tank shall be used.

1.8 LOSSES

≫ Transformers with lower losses are required. The quoted losses will be capitalized by using appropriate formula and taken into account for evaluation of tender.

≫ The no-load loss in KW at the rated voltage and frequency and the load- loss in KW at the rated voltage, rated frequency rated output and at 75°C shall be quoted and these figures shall be guaranteed.

≫ THE LOSSES SHALL BE GUARANTEED WITHOUT POSITIVE TOLERANCE.

≫ If the test figures exceed the quoted values, the transformer will be rejected/capitalized.

1.9 CONSTRUCTIONAL FEATURES

≫ The transformer and accessories shall be designed to facilitate operation, inspection, maintenance and repairs.

≫ All materials used shall be of the best quality and of the class most suitable for working under the conditions specified and shall withstand the variations of temperature and atmospheric conditions, arising under working conditions, without undue distortion or deterioration or setting up of undue stresses in any part and also without affecting the strength and suitability of the various parts for the work which they have to perform.

≫ No patching, plugging, shimming or other such means of overcoming defects, discrepancies or errors will be accepted.

≫ Corresponding parts liable for replacement shall be interchangeable.

≫ All outdoor apparatus, including bushing insulations with their mounting shall be designed so as to avoid pocket in which water can collect.

≫ All mechanism shall wherever necessary, be constructed of stainless steel, brass or gun metal to prevent sticking due to rust or corrosion.

≫ All taper pins used in any mechanism shall be of the split type.

≫ Nuts, bolts and pins used inside the transformer and tap changer compartment shall be provided with spring washers or locknuts, where gaskets are not used. Galvanizing where specified shall be supplied by the hot dipped process or by Electro Galvanizing process and for all parts other than steel wires which shall consist of a thickness of zinc coating equivalent to not less than 610 gm of zinc per square meter of outer surface. The zinc coating shall be smooth, of uniform thickness and free from defects.

≫ Surface, which are in contact with oil, shall not be galvanized or cadmium plated.

≫ Labels or plates of non-corrosive material shall be provided for all apparatus such as relays, switches and fuses, contained in any cubicle or marshalling kiosks.

≫ Steel bolts and nuts exposed to atmosphere shall be with suitable finishes like cadmium plated or zinc plated.

≫ Before painting or filling with oil ungalvanised parts oil ungalvanised parts shall be completely cleaned and freed from rust, scale and greases, and all external surface cavities on castings shall be filled by metal position.

≫ The interior of transformer tank and other oil filled chambers and internal structural steel work shall be cleaned off all scale and rust by shot-blasting or sand-blasting. These surfaces shall be painted not less than two coats of hot oil resisting varnish or paint. Unexposed welds need not be painted.

≫ Similarly the outer surface shall also be cleaned off all scale and rust by shot/sand blasting then the primary coat shall be applied, immediately after cleaning. The second coat shall be of epoxy paint.

≫ All interior surfaces or mechanism chambers and kiosks except those, which have received anti corrosion treatment, shall receive three coats of paint, applied to the thoroughly cleaned metal surface. The final cost shall be of a light coloured anti condensation mixture.

≫ Metal parts not accessible for painting shall be made of corrosion resistant material.

1.10 CORE

≫ The cores shall be constructed from high grade, cold rooled, non-ageing, high permeability, LOW LOSS super grain oriented, and silicon steel laminations. The maximum flux density in the core shall not exceed 1.7Tesla for Power transformer. Necessary design data shall be furnished by the tenderer for verification.

≫ Oil ducts shall be provided, where necessary, to ensure adequate cooling. The winding structure and major insulation shall not obstruct the free flow of oil through such ducts. Where the magnetic circuit is divided into pockets by cooling ducts, parallel to the planes of the core alloy or by insulating material above 0.25mm thick, tinned copper strip bridging pieces shall be inserted to maintain electrical continuity between pockets. The framework and clamping arrangements shall be earthed as specified separately.

≫ The insulation structure for the core to bolts and core to clamp plates shall be such as to withstand a voltage of 2500V AC for one minute. The bolts and clamps, used in the assembly of the core, shall be suitably insulated with fiberglass tubes and the clamping structure shall be constructed so that eddy current will be minimum.

≫ All parts of the core shall be of robust design, capable of withstanding any shocks to which they may be subjected during lifting, transport, installation and service.

≫ All steel sections, used for supporting the core, shall be thoroughly sand blasted or shot-blasted after cutting, drilling and welding.

≫ Adequate lifting lugs shall be provided to enable the core and windings to be lifted.

≫ Adequate provision shall be made to prevent movement of the core winding. Relative to the tank, during transport and installation or while in advance.

≫ The supporting frame work of the core shall be so designed as to avoid the presence of pockets which would prevent complete emptying of the tank through the drain valve or cause trapping of air during filling.

1.11 WINDING

≫ The conductor shall be of electrolytic grade copper and windings made in dust proof atmosphere.

≫ Coils of the windings of identical voltage and rating shall be interchangeable.

≫ The windings shall have uniform insulation. The neutral point shall be insulated for the voltage specified in IS: 2026.

≫ The windings shall be designed to reduce the out of balance forces in the transformer to a minimum. They shall withstand the impulse and power frequency test voltages as specified in this specification. The manufacturer shall indicate the type of winding provided and reason transformer oil during service.

≫ The stacks of windings shall receive adequate shrinkage treatment before final assembly. Adjustable devices shall be provided for taking up any possible shrinkage of coils in service.

≫ Coils shall be supported at frequent intervals by means of wedge type insulation spacers permanently secured in place and arranged to ensure proper oil circulation. To ensure permanent tightness of wiring assembly, the insulation spacers shall be dried and compressed at high pressure before use.

≫ The completed core and coil assembly shall be dried in vacuum at not more than 0.5mm of mercury absolute pressure and shall be immediately impregnated with oil after process to ensure the elimination of air and moisture within the insulation.

≫ All threaded connections shall be provided with locking facilities. All leads from the winding to terminal board and bushings shall be rigidly supported to prevent injury from vibration. Guide tubes shall be used where practicable.

≫ Adequate insulation and clearances between high voltage windings and low voltage windings shall be provided. All clearances of windings another live parts shall be adequate for the normal voltage of operation plus 10%.

≫ The coil clamping arrangement and the finished dimensions of any oil duct shall be such as not to impede the free circulation of oil through the ducts.

≫ The strip conductor wound on edge shall not have a width exceeding six times its thickness.

≫ The conductors shall be transposed at sufficient intervals in order to minimize

≫ Eddy current and equalize the distribution of currents and temperature along the windings.

≫ The connections of all windings shall be braced.

≫ Coil clamping rings, if provided, shall be of steel or of suitable insulating material. Axially laminated material, other than backelised paper, shall not be used. End coil clamping shall be adequate to prevent distortion of end coils under any types of fault condition.
≫ Inter earthing arrangements shall be provided to maintain al metal parts at earth potential

1.12 TANK AND TANK ACCESSORIRS

Tank Construction

≫ The transformer tank shall be of conventional type. The transformer tank and cover shall be fabricated from good quality low carbon steel adequate thickness and shall be designed to withstand lifting of the complete transformer with the tank filled with oil by crane or jacks and transportation by road or rail without over staining any joints and without causing subsequent leakage of coil. Adequate stiffeners shall be provided, wherever necessary, for tank plates.

≫ The base of such tank shall be designed that it shall possible to move the complete transformer by skidding in any direction without injury plates or rails.

≫ The tank shall be capable of withstanding filling by vacuum, continuous internal pressure of **0.35Kg/cm.sq.** (5 lb/sq. inch) over normal hydrostatic pressure of oil, short circuit forces and full vacuum for drying out purpose.

≫ Adequate space shall be provided at the bottom of the tank for collection of sediments. Suitable guides shall be provided positioning various parts assembly or dismantling.

≫ The base (if of channel construction) and tank stiffeners shall be designed to prevent retention of water.

≫ Wherever possible, the transformer tank and its accessories shall be designed without pockets, wherein gas may collect. Where pockets cannot be avoided, pipes shall be provided to vent the gas into the main expansion pipe. The vent pipes shall have a minimum inside diameter of 15mm except for short branch pipes, which may have 6mm minimum inside diameter.

≫ All seams and joints, other than those which may have to be opened, shall be welded and wherever possible, double welded. All welding shall be stress relieved, if required.

1.13 Lifting and Haulage Facilities

≫ Each tank shall be provided with:

≫ Lifting lugs, suitable for lifting the transformer complete with oil.

≫ Pulling eyes shall be provided to facilitate movement of the transformer and they shall be suitably braced in vertical direction, so that bending does not occur when the pulls has vertical component.

≫ Lashing lugs.

≫ A minimum of four jacking pads at a height of 500mm to enable the transformers, complete with oil to be raised or lowered using hydraulic or screw jacks.

1.14 Tank cover

≫ The detachable tank cover shall be designed for adequate strength, to prevent distortion when lifted, and to prevent collection of water on any part. It must be separate from the core and coil and shall be capable of being lifted separately from the tank for inspecting the core and winding at site. Inspection openings shall be provided, as necessary to give easy access to bushings, core and windings, OLTC, earth connection, etc. Each inspection opening shall be ample size for purpose for which it is provided and atleast two openings one at each end of the tank shall be provided.

≫ The tank cover shall be provided with suitable lifting arrangements. Unless otherwise approved, inspection covers shall not weight more than 25kg each.

≫ The tank cover shall be fitted with pockets at the position of maximum oil temperature for the bulbs of oil winding temperature indicators. Protection shall be provided where necessary for each capillary tube, it shall be possible to remove these bulbs without lowering the oil in water.

≫ Temperature indicator pockets shall be fitted with a captive screwed top to prevent ingress of water.

1.15 OIL

≫ The transformer and all associated oil filled equipment's shall be supplied along with sufficient of oil, free from moisture and having uniform quality throughout for the first filling of the tank, coolers and radiators along with 10% extra oil for topping up in non-returnable containers, suitable for outdoor storage. No inhibitors shall be used in the oil. The transformer oil required for first filling at site (excluding the oil absorbed by winding, insulation, etc.) may be furnished in the tender offer. This shall exclude the oil absorbed in the windings and insulation materials.

≫ The oil shall conform to IS 335 of latest issue.

≫ The design and materials used in the construction of the transformer shall be such as to reduce the risk of the development of activity in the oil.

1.16 AXLES AND WHEELS

≫ The transformer are to be provided with bi-directional flanged wheels and axles of suitable dimensions and so supported that under any service condition, they shall not deflect sufficiently to interface with the movement of the transformer, complete with oil. Suitable locking arrangements shall be provided to prevent the accidental movement of the transformer.

≫ All wheels should be detachable and shall be provided with suitable bearings, which shall be rust and corrosion resistant. Fittings for lubrication shall also be provided. The flanged wheel shall be suitable for use on gauge track and shall be so placed that a pinchbar can be used to move the transformer. Track shall be of 1676mm gauge between adjacent rails both on longer and shorter axis.

≫ The wheels shall be arranged so that they can be turned through an angle of 90°. (on both directions) when the tank is jacked up, clear of the rails or floor. Necessary jacking steps shall be provided. Means shall be provided for locking the swivel movements in positions parallel to and at right angles to the longitudinal axis of the tank.

1.17 CONSERVATOR VESSEL, OIL GAUGE AND BREATHERS

≫ A conservator, complete with sump and drain valve, shall be provided in such a position, as not to obstruct the electrical connections to the transformer, having a capacity between highest and lowest visible levels to meet the requirements of expansion of the total cold oil volume in the transformer and cooling equipment from the minimum ambient temperature to 100° C. The minimum indicated oil level, shall be with the feed pipe from the main tank covered with not less than 15mm depth of oil and the indicated range of oil level shall be from minimum to maximum.

≫ The conservator shall be designed, so that it can be completely drained by means of the drain valve provided, when mounted as in service.

1.18 Accessories

a) One end of the conservator shall have bolted cover, so that it can be removed for cleaning purpose.
b) Magnetic type oil gauge, having
1) Dial, showing minimum, maximum and normal (at 30deg.C) oil levels shall be provided.
c) Oil filing valve and drain valve
d) The conservator vessel shall be fitted with breathers in which silicagel is a dehydrating agent and designed so that

1) The passage of air is through silicagel
2) The silicagel is isolated from atmosphere by an oil seal.
3) The moisture absorption, indicated by a change in colour of the tinted crystals, can be easily observed from distance.
4) The breather shall be mounted at approximately 1400mm above ground level.

≫ The oil connection from the transformer tank to the conservator vessel be arranged at a rising angle of **3 to 7 ° to** the horizontal with 80mm dia pipe and shut-off valve in between the tank and gas and oil actuated relay.

≫ A valve shall be provided at the conservator end to cut off the supply to the transformer tank, after providing a straight run of pipe for atleast a length of 5 times the internal diameter of the pipe on the tank side of the gas and oil actuated relay and at least 3 times the internal diameter of the pipe on the conservator side of the gas and oil actuated relay.

1.19 VALVES AND AIR RELEASE PLUGS

≫ Each tank shall be equipped with the following valves:

a) Oil valves between **Radiator** and tank
b) One 80mm drain valve with padlocking arrangement located in the low valtage side of the transformer.
c) Two 50mm filter valves one on the top of the transformer and at a diagonally apposite end to that of drain valve and another at the bottom with padlocking arrangement. These shall have adapter suitable for 32mm hose
d) Two sampling valves (size 20mm) at toe and bottom of the main tank, with provision for fixing PVC pipe.
e) One 15mm air release plug.

≫ All valves with opening to atmosphere shall be fitted with blank flanges.

≫ All valves shall be of gunmetal or cast steels or may have cast iron bodies with gunmetal fittings.

≫ Valves shall be provided with flanges, having machined faces/screw connection for external piping.

1.20 PRESSURE RELIEF DEVICE

≫ A Pressure relief device shall be mounted on the main tank, and if on the top cover, shall be fitted with skirt projected 25mm inside the tank and of such a design to prevent gas accumulation.

≫ The Pressure relief device shall be of sufficient size for rapid of any pressure that may be generated within the tank and which might result in damage to the equipment. The device shall operate at a static pressure of less than the hydraulic test pressure for transformer tank. Means shall be provided to prevent the ingress of rain.

≫ The pressure relief device shall be of safety valve type, capable of releasing after any pressure developed in the tank. It shall be provided with switches for actuating alarm and trip contacts, when it acts. The switches shall be able to be reset, once the pressure is released.

≫ As per Rule 64-A-2-C of **IER 1956** under the head 'Protection' Gas pressure type and winding and oil temperature protection to give alarm and tripping shall be provided on all transformers of rating 1000 KVA and above.

1.21 EARTHING ARRANGEMENTS

≫ All metal parts of the transformer with exception of the individual core laminations core bolts and associated individual clamping plates shall be earthed to the tank by means of copper strap.

≫ Two earthing terminals (at diagonally opposite bottom corner of the tank), capable of carrying the short circuit current for 4 seconds without injurious heating shall be provided with clamp type terminal.

1.22 RATING AND DIAGRAM PLATES

≫ The following plates of stainless steel make use, shall be fixed to the transformer tank, at an average height of about 1750mm above ground level.

a) A rating plate, bearing the data specified in the appropriate clause of IS: 2026. The details of the current transformer and normal and operating pressure of pressure relief valve may also be furnished.

b) A diagram plate, showing the internal connections and also the voltage vector relationship of the several windings in accordance with IS: 2026 and in addition a plan view of the transformer giving the correct physical relationship of the terminals. No load voltage shall also be indicated for each tap.

c) A plate showing the location and function of all valves and air release cocks or

Plugs. This plate shall also warn operators to refer to the maintenance instructions before applying the vacuum treatment for drying.

c) A plate showing the schematic wiring diagram of the respective cubicle may be

Provided in the cubicle.

1.23 JOINTS AND GASKETS

≫ All bolted connections shall be fitted with weather proof, hot oil resistant gaskets in between, for complete oil tightness. Special attention shall be given to the oil tight joints between the tank and the cover and the bushing and other outlets to prevent ingress of water into or leakage of oil even under hot condition from the tank.

1.24 TERMINAL ARRANGEMENTS

L.V.Side

≫ L.V.Side with suitable bushing and Flange shall be provided to terminate 3 Runs – 3.5 C 400 sq. mm XLPE Aluminium armoured cable.

1.25 TERMINAL BOX

≫ All bushings shall be equipped with suitable terminals and terminal clamps of approved type and all external current carrying contact surfaces shall be adequately silver plated. Main terminals shall be solderless. Flexible connectors shall be made from tinned copper sheets, size of terminal/conductor for which the clamp is suitable and the rated current shall be embossed/punched on each clamp.

≫ Each bushing shall be co-ordinated with the insulation class of the winding.

≫ All porcelain, used in bushings, shall be homogeneous and free from cavities or other flaws. The glazing shall be uniform in colour and free from blisters, burrs and other defects. The glaze shall be brown.

≫ Stress shield for the bushings shall be considered as an integral part of the bushing assembly.

≫ Clamps and flanges shall not be re-entrant shape, which may trap air.

≫ The minimum clearance of air between live phase to phase and phase to earth shall be as follows as CBI & P.

Sl.No.	Rated Voltage KV (RMS)	Clearances in millimeter	
		Phase to phase Clearance	Phase to Earth Clearance
01	11KV	127	77
02	433V	19	16

≫ The bushings shall carry marks as specified below:[

a) Manufacturer's name or trade mark
b) Year of manufacture
c) Manufacturer's serial number
d) Rated voltage
e) Rated line to earth voltage
f) Insulation level
g) Rated current
h) Rated frequency
i) Creepase distance
j) Maximum permissible angle of inclination, if exceeding 30°. To the vertical for liquid filled bushings.
k) Weight.

1.26 VOLTAGE CONTROL EQUIPMENT: NO LOAD TAP CHANGER

≫ The transformer shall be provided with no load, tap changing mechanism on HV side (11KV) of transformer as per IS: 8468. The TC shall maintain the LV voltage for variations of HV side to keep the voltage close to rated voltage. All tapping shall be designed for full power rating.

≫ The TC shall be suitable for unidirectional flow of power. The no load tap changer shall include the following:

a) An oil immersed tap selector and arching switch or arc suppressing tap selector, provided with reactor or resister for reduction of make and break arching voltages, over loads and short circuits.
b) Control and protection devices.
c) Local tap changer position indicator.
d) Manual operating device.

≫ The no load tap changer shall be designed so that the contactors do not interrupt are within the main tank of the transformer. The tap selector and arcing switch or arc suppressing tap selector switch shall be located in one or more oil filled compartments. The oil in the compartments shall be maintained under conservator head by means of a pipe connection form the highest point of the chamber to the conservator. This connection shall be controlled by a suitable valve and shall be arranged so that any gas leaving the chamber will pass into the gas and oil actuated relay. This oil surge relay fitted between the tap chamber compartment and the conservator shall be of reputed make.

≫ It shall be designed so as to prevent the oil in the tap selector compartment from mixing with the oil in the transformer tank.

≫ It is preferable that the contacts shall be assessable for inspection without lowering oil level in the main tank and the contact tips replaceable.

≫ Provision with suitable valve shall be made for equalization of diverted compartment and main tank during application of vacuum at site.

1.27 Mechanical Control

≫ The transformer shall give full load output on all taps. The manual operating device shall be removable and located at a height not exceeding 1500mm above ground level so that it can be operated by a man standing at the level of the

transformer track. It shall be strong and robust in construction. The mechanism shall be complete with normal accessories including atleast the following:

a) Tap changing indicator
b) Mechanical operation counter
c) Mechanical stops to prevent over cranking the mechanism
Beyond extreme tap position

1.28 Local Indoor Tap changing cubicle

≫ The tap changer shall contain the following:
a) Tap position indicator
b) Limiting devices
c) Operation counter
d) Over current blocking device.

1.29 COOLING

≫ The transformer shall be supplied with the requisite number of radiators or coolers.

≫ Radiators and coolers shall be so designed as to avoid pockets in which moisture may collect and shall withstand the pressure test. They shall be accessible for cleaning and painting, to prevent accumulation of water on the outer surface to completely drain oil from the tank, to ensure against formation of gas pockets when the tank is being filled.

≫ Radiator, connected directly to the tank, shall be detachable and shall be provided with machined or ground flanged inlet and outlet branches with facilities provided for draining and filling of each radiator.

≫ Valves shall be provided on the tank at each point of connection to the tank.

≫ Where separate radiator banks are provided, the conservator vessels can be mounted thereon.

≫ The oil circuit of all coolers shall be provided with the following:

a) A value at each point of connection to the transformer tank.

b) Removable blanking plates to permit the blanking off the main oil connection of each cooler.
c) A drain flange type CI ball valve of size 25mm at the lowest point of each bank of cooler.
d) Air release plugs of 15mm dia.

≫ The necessary oil piping shall be provided for connecting the transformer to the collers. The oil piping shall be with flanged gasket joints. Coat iron shall not be used.
≫ The drilling of all pipe flanges shall comply with IS: 3639.
≫ A suitable extension piece shall be provided in each oil pipe connecting between the transformer and the separately mounted oil cooler.

1.30 TEMPERATURE CONTROLLERS

a) The transformer shall be provided with one oil temperature indicator, fitted with maximum pointer.
b) The transformer shall also be provided with one Winding Temperature Indicator fitted with maximum pointer. The temperature indicators shall be of dial type (not less that 150mm dia) and robust pattern.
c) The temperature indicator shall be fitted din a tank mounted, whether proof, and marshalling box.

1.31 MARSHALLING BOX

≫ Tank mounted, sheet steel vermin and weather proof marshalling box, shall be provided with a controlled metal clad heater to accommodate the following equipments.

a) Temperature indicators

≫ A plate showing the schematic wiring diagram may be provided in the marshalling box for ready reference.

1.32 CONTROL WIRING, TERMINAL BOARDS, FUSES ETC.

≫ All wiring connections, terminal boards, fuses and links shall be suitable for tropical atmosphere. Any wiring liable to be in contact with shall have oil resisting insulation and the board ends of standard wire shall be sweated together to prevent creepage of oil along the wire.

≫ There shall be no possibility of oil entering into the connection boxes, used for cables or wiring.

≫ Panel, connections shall be neatly and squarely fixed to the panel. All instruments and panel wiring shall be run in PVC or non-rusting metal cleats of the limited compression type. All wiring to a panel shall be taken from suitable terminal boards.

≫ Where conducts are used, the runs shall be laid with suitable falls, and the lowest parts of the run shall be external to the boxes. All conduit runs shall be adequately drained and ventilated. Conduits shall be run at or below ground level.

≫ Multicore cable tails shall be so bound that each wire may be traced without difficulty to its cable.

≫ All terminal boards shall be obliquely towards the rear doors to give easy access to terminations and to enable ferrule numbers to be read without difficulty.

≫ Terminal board rows would be spaced adequately, not less than 10mm apart to permit convenient access to wires and terminations.

≫ Terminal boards shall be so placed with respect to the cable gland (at a minimum distance of 300mm), as to permit satisfactory arrangement of Multicore cable tails.

≫ Terminal boards shall have pairs of terminals for incoming and outgoing wires. Insulation barriers shall be provided between adjacent connections. The height of the barriers and the spacing between terminals shall be such as to give adequate protection while allowing easy access to terminals. The terminals shall be adequately protected with insulation dust proof covers.

≫ No live metal shall be exposed at the back of the terminal boards.

≫ All fuses shall be of the cartridge type

≫ Fuses and links shall be labeled.

1.33 FITTINGS AND ACESSORIES

≫ The fittings and accessories mentioned in this order are only indicative and any other fittings, which are generally required for satisfactory operation of the transformer, are deemed to be included.

1.34 CENTRE OF GRAVITY

≫ The centre of gravity of the assembled transformer shall be low and as near the vertical centre line as possible. The transformer shall be stable with or without oil. If the centre of gravity is eccentric, relative to track either with or without oil, its location shall be shown in the 'outline' drawing.

1.35 QUALITY PLAN

≫ The terderer shall furnish the programme of manufacturing works, PURCHASER / CONSULTANT shall have access to visit the company at the different stages of manufacture and to ensure the quality of components used in the manufacturing process.

≫ Documents like purchase orders, invoice or receipted chalans, detailing the source of supply of raw materials and their specification, shall be given by the supplier on demand either during the manufacturing process or at the time of inspection of the transformer, ordered.

TECHNICAL REQUIREMENTS

Transformer rating (Continuous) KVA	500KVA
Duty / Application	Continuous / Power Distribution
Service	Outdoor
Type of winding / Core	Double Wound / Core type **(Suitable for low loss)**
Winding material	Copper /electrolytic grade.
Type of cooling	ONAN
No. of phases	Three
Supply frequency	50Hz
Primary winding (H.V/Incoming side)	Delta

Secondary winding (L.V. Outgoing side) Neutral	Star with Brought out
Vector Group Symbol (as per IS 2026)	Dyn 11
Percentage Impedance	5 %

Ambient conditions (as per IS 2026)

a) Max ambient air temperature	50° C
b) Max daily average air temperature	40° C
c) Max yearly weighted average air temperature	32° C
d) Minimum ambient air temperature	5° C

e) Minimum Altitude (above M.S.L)
Guaranteed Temperature rise over above ambient conditions:

a) By thermometer in top-oil	50° C
b) By winding resistance method	55° C
Nominal Primary Voltage	11,000Volts
Nominal Secondary Voltage	433 Volts
Tapping in HV side	Provided for variation of Incoming voltage.

Type of tap-changing arrangement NO-Load tap changer.

No. of tap steps / positions	16steps/17 positions
Tapping range +5% to –15% in 1.25% steps	
Incoming side voltage compensation range	11.55 KV to 9.35 KV

Terminal arrangements:

HV INDOOR Cable box type
LVCabel Box (Suitable for 3R x 3.5 C 400 sq.mm XLPE Al. Ar. cable.

STANDARD FITTINGS

- Rating Plate with diagram and terminal marking plates
- Conservator Tank- (with shut off valves)
- Prismatic oil level Gauge
- Conservator Drain plug.
- Inspection cover.
- Two Earthing Terminals.
- Lifting Lugs for Lifting core and coils.
- Lifting Lugs for lifting the transformer complete with oil
- Drain cum sampling valve with plug on cover plate.
- Dehydrating Silicagel breather 2Kg.
- Thermometer pockets for oil & winding Temperature Indicator
- Air release device
- Oil filling valve
- Filter valve at Top
- Pressure releasing valve
- Base channel with skids
- Jacking lugs
- Bi-directional flat treaded rollers with axles
- Radiators – Pressed steel type – detachable with butterfly valves
- Earthing connection between tank and cover

- Earthing connection between radiator and tank

- Additional Neutral bushing assembly confirming to IS3347, Rating 1.1KV/400A

Other FITTINGS

- 150mm Dial capillary type temperature indicator for oil with maximum indication pointer & necessary re setting device

- 150mm Dial capillary type temperature indicator for winding temperature Indicator with maximum indication pointer & necessary re setting device
- Magnetic oil level guage with low oil level alarm
- Gas sampling device at an accessible height and air release cock
- Marshaling Box to house dial type thermometers and terminal blocks with control wiring

SPECIAL FITTINGS:

As per recent amended Indian electricity rules As per Rule 64-A-2-C of **IER 1956** under the head 'Protection' Gas pressure type and winding and oil temperature protection to give alarm and tripping shall be provided on all transformers of rating 1000 KVA and above.

The transformer should be of Low loss Type.

The transformer shall conform to I.S 2026 (Parts _ HV) and CBIP Manual on Power Transformers, and standard manufacturing practice with first fill of oil.

INSPECTION

≫ The accredited representative of the purchases shall have access to the contractor or sub-contractor's works at any time during working hours for the purpose of inspection of manufacture or test on the plant and selection of samples of the materials going into the equipment. The contractor shall provide necessary facilities for such inspection or test.

≫ The core and coil assembly shall be offered for our inspection prior to tanking and the readiness for such inspection shall be intimated atleast 15 days in advance. The tanking of core and coil assembly shall be taken up only after our approval in this regard.

≫ All the type / special / routine tests on the transformer as per IS 2026 of latest issue and indicated below will be witnessed by PURCHASER / CONSULTANT'S Engineers and all necessary facilities for inspection and testing shall be provided by the supplier. The transformer shall be completely assembled and tested at the factory.

≫ The supplier shall ensure that the test instruments have calibration certificate issued by an approved standard laboratory, not earlier than six months from the date of testing.

≫ The readiness of the transformer for testing and out final inspection shall be intimated atleast 15 days in advance for deputed Engineers for inspection / witnessing the tests. The transformer will be accepted at site by the consignees Engineer only on production of the approved test certificates.

FACTORY ASSEMBLY AND TESTS

Type / special / Routine tests

≫ The following type / special test as per IS: 2026 of latest issue shall be carried out on one unit in the presence of representative from PURCHASER / CONSULTANT.

a) Vacuum test on the transformer tank: As per CBIP Specification.
b) Temperature rise test at the barest tap position.
c) Impulse voltage withstands test on all 3 phase including chopped impulses. (This test shall precede power frequency high voltage tests).

≫ The following routine tests as per IS 2026 of latest issue and special tests shall also be carried out on the transformers free of cost.

a) Measurement of winding resistance.
b) Measurement of voltage ratio and check of voltage vector relationship.
c) Measurement of impedance voltage / short circuit impedance (principal tapping) and load loss.
d) Measurement of no load and current.
e) Measurement of insulation resistance.
f) Dielectric tests (Power frequency voltage test and induced over voltage withstand test).
g) Oil leakage test on transformer tank. The tank and oil filled compartments shall be tested for oil tightness by completely filling with

air / oil of viscosity not greater than that of insulating oil, conforming to IS: 335 1983/1987 at the ambient temperature and applying a pressure, equal to the normal pressure plus 0.35 Kg/cm.sq. measured at the base of the tank. This pressure shall be maintained for a period of not less than 12 hours for oil and one hour for air during which time no leakage shall occur.

h) Magnetic balancing test.

i) Measurement of no load current with 415 volts supply.

j) Check for polarity and ratio tests for knee point voltage

k) Die Electric Test of oil

⩾ The test sequence shall be: Tests on transformers tank, heat run test, pressure test on the assembled transformer, impulse test, routine tests and special tests.

FUTURE TESTS

The purchaser reserves the right of having other reasonable tests carried out at his own expense before transport at site, to ensure that the transformer complies with the requirements of our specification.

TESTS AT SITE

After erection at site, the transformer shall be subjected to the following tests:

- Insulation resistance test.
- Ratio and polarity test on all taps.
- Dielectric test on oil.
- Open circuit.
- Operation test of protection devices and interlocks
- Measurement of winding resistance at all taps.
- Load test at 100% for 2 Hrs and 110% for 1 Hr

TEST CERTIFICATES

a) Six copies of the test certificates on the above type tests / special tests / routing tests with the endorsement of the Inspecting Officer shall be furnished for approval.

b) The test report shall supply the following information

c) Complete identification data, including serial no. of the transformer.
d) Method of application where applied, duration, and interpretation of results in each test.
e) Temperature data corrected to 75° C including ambient temperature.

≫ The equipment will rejected if test results are not in conformity with the Guaranteed Techinical particulars.

≫ Besides the above test certificates, manufacturer's test certificates in respect of the following accessories shall also be furnished in six copies.

a) Bushings
b) Magnetic oil level gauge
c) Winding temperature controller
d) Oil temperature controller
e) Radiators
f) Transformer oil

≫ The supplier shall also furnish test certificates to the effect that the transformer core has been tested after assembly and immediately prior to the despatch of the transformer for one minute at 2500 volts AC between all bolts, side plates and structural work.

DRAWINGS, TECHNICAL LITERATURE AND GUARANTEED TECHNICAL PARTICULARS

≫ The following detailed drawings shall be submitted within 7 days from the date of award of contract.

a) General Arrangement drawing, showing front side elevations and plan views of the transformer and all accessories and external features with detailed dimensions, weights, crane life for untanking and for erection / removal of bushings, size of lifting lugs and pulling eyes, HV and LV terminal clearances, live terminal to ground clearance, quantity of insulating oil, dimensional details for foundation.
b) Assembly drawings of HV, LV and Neutral groundings.
c) Schematic control and wiring drawing and drawings showing temperature indicator circuits and control system for cooling equipments.
d) Drawings showing construction and mounting details of marshalling box.
e) Drawing, giving details of name plate, terminal marking and connection diagram.

f) The magnetization characteristic curves of the bushing current transformers, indicating the knee point voltage excitation current and secondary resistance.
g) Drawing on terminal Blocks.

≫ Six complete sets of final drawings shall be supplied for the transformer, sufficiently before the actual despatch of the equipment.

≫ Six copies of all bulletins, complete instruction manuals for the erection, operation and maintenance of the transformer are to be supplied before they are dispatched.

≫ Any approval given to the detailed drawings by the purchaser shall not relieve the contractor of the responsibility for the correctness of the design, completeness of the equipment supplied and in the execution of the works in accordance with the terms of specification.

REJECTION

≫ The transformer may be rejected if during the tests on any of the following conditions arise:

a) No load losses exceed the guaranteed value beyond tolerances, specified.
b) Load losses exceed the guaranteed value beyond tolerances, specified.
c) Impedance valve exceeds by the guaranteed value by +5%
d) Transformer fails on impulse test.
e) Transformer fails on power frequency voltage withstand test. If either of the test results conducted at factory and site are not satisfactory.
f) Transformer is proved to have been manufactured not in accordance with the agreed specification and approved drawings.

SPARES

COMMISSIONING SPARES

≫ The bidder shall submit a recommended list of commissioning spares along with the item wise price for each component.

MAINTENANCE SPARES

≫ The bidder shall submit a recommended list of maintenance spare parts list for 2 years of smooth and trouble free operation of the transformer along with item wise price for each component. These shall include but not limited to complete set of gaskets.

a. One bushing of each type.

b. Dial type thermometer.

c. Oil level gauge.

d. Complete set of winding temperature-indicating equipment.

e. One valve of each type.

f. Silica gel breather.

g. one set of gaskets.

GUARANTEED TECHNICAL PARTICULARS FOR TRANSFOMERS			
(TO BE FILLED IN BY THE TENDERER)			
S.No	*Description*	*Units*	**To be filled by the bidders.**
1	Name of the Manufacturer or Type of Transformer		
2	Services (Outdoor/Indoor)		
3	Rating		
	a. ONAN	KVA	
4	Rated Frequency	HZ	
5	Number of phases		
6	Rated Voltage		

	a. HV Winding	KV	
	b. LV Winding	KV	
7	Vector group symbol		
8	Type of cooling	(ONAN)	
9	Tapping		
	a. Range		
	b. Number of Steps.		
	c. Tapping provided on HV Side.		
10	Losses (at 75 Deg Centigrade and principal tapping)		
	a. No load loss at rated voltage and frequency.		
	b. Load loss at rated current (ONAN)- Subject to IS Tolerance.		
	c. Total loss at maximum rated power.		
11	Impedance voltage at 75 ° C		
	a. At principal tapping	%	
	b. At maximum tapping	%	
	c. At minimum tapping	ORDER	
12	Reactance at rated current and frequency	%	
13	Resistance at rated current and 75 ° C		
	a. HV	OHMS/PHASE	
	b. LV	OHMS/PHASE	
14	Zero sequence impedance	%	
15	Zero sequence capacitance of HV winding	MICRO	

		FRAD	
16	Temperature rise above 45 ° C ambiuent		
	a. Top of oil by thermometer		
17	Hottest spot temperature in winding limit to over an maximum yearly weighted average ambient temperature of 32 ° C		
18	Efficiency at 75 ° C and 0.8 PF		
	a. At full load (ONAN/ONAF)	%	
	b. At 75% load (ONAN/ONAF)	%	
	c. At 50% load (ONAN/ONAF)	%	
19	Load and Power Factor at which maximum efficiency occurs % full load		
20	Maximum efficiency		
21	Regulation at full load and at 75 ° C.		
	a. At unity PF	%	
	b. At 0.8 PF lagging	%	
22	No Load current referred to 0 HV and 50 HZ (approx.)		
	a. At 90% rated voltage	A	
	b. At 100% rated voltage	A	
	c. At 110% rated voltage	A	
23	Maximum current density at rated power		
	a. HV winding		
	b. LV Winding		
24	Maximum Flux density in iron at rated voltage ratio and at rated frequency		

	a. At 100% rated voltage	TESLA	
	b. At 110% rated voltage	TESLA	
25	Maximum clearance in air		
	a. Between phases (HV/LV)	MM	
	b. Between Phases & Ground.	MM	
26	Insulation Level		
	a. Impulse		
	I. HV	KV(PEAK)	
	ii. LV	KV(PEAK)	
27	Power Frequency		
	HV	KV(rms)	
	LV	KV(rms)	
28	Winding Type		
	HV		
	LV		
29	Insulation Material		
	HV		
	LV		
	Tapping leads		
	Core to LV		
	HV to LV		
30	Details of Core		
	a. Core Lamination Materials		

	Thickness of laminations		
	Insulation of lamination		
	Type (Shell or Core)		
	Specific loss of Core steel at 1.5 tesla		
31	Details of tank:		
	a. Material		
	Thickness of side	mm	
	Thickness of bottom	mm	
	Thickness of cover	mm	
	Thickness of Tube	mm	
	Maximum internal pressure the tank is capable of		
	No. of Limbs(core type)		
32	Details of conservator Main Tank		
	a. Volume of Conservator Main Tank	Ltrs.	
	b. Volume of oil between the highest & the lowest level.	Ltrs.	
33	Details of Radiator		
	a. No. of Radiator tanks		
	Thickness of the radiator tanks	mm	
	weight of each radiator		
	Cooling surface area	mm	
34	Details of oil:		
	a. Total Oil Required in Ltrs.		
	b. Whether first fillling of oil with 10% excess in non returnable drums furnished.		

	c. Oil confirms to standard.		
35	Details of Bushing:		
	a. Make		
	b. Type		
	c. Voltage class		
	d. Weight of bushing	Kg	
	e. Creepage distance	m	
	f. Applicabe standard		
	g. Current rating		
	h. Insulation Level.		
	Impulse	KV(PEAK)	
	Power frequency dry KV		
	Power frequency wet	KV(rms)	
	I. Length of Insulator	M	
	j. Loss angle at working voltage	Tan	
36	Explosion vent:		
	a. Material		
	b. Thickness		
	c. Minimum pressure the diaphragm is set to ruprure.		
37	Breather type:		
	a. Transformer		
38	Tank pressure test		

	a. Pressure	Kg/m	
	b. Duration	Hours	
39	Tank Vacuum Test:		
	Vacuum	Hours	
	Duration		
40	Maximum Noise Level	db	
41	Approximate Maximum overall dimensions including coolers and fittings.		
	Height	mm	
	Breadth	mm	
	Length	mm	
	Crane lift for untaking core and coil assembly (including sling)		
42	Shipping Dimensions		
a	Height	mm	
b	Breadth	mm	
c	Length	mm	
43	Weight		
	Core winding	kg	
	Tank and fittings	kg	
	Oil	kg	
	Total weight including cooling gear, tap changer fittings and oil		
	Shipping weight	kg	
44	Reference Standard	kg	

TECHNICAL SPECIFICATION FOR XLPE 11KV POWER CABLE

SCOPE

This specification covers the Technical requirements of Design, Manufacture, and Testing at manufacturer's works and delivery at site properly packed in wooden drums of 11 KV 50 Hz cross linked polyethylene (XLPE) Aluminium conductor power cables suitable for solidly grounded system as specified herein under.

STANDARDS

The cables covered by this specification unless otherwise stated are designed in accordance with the latest editions of the following standards.

IS 7098 (Part II & III), IEC 502 & IEC 287	-	Specification for cross linked polyethylene insulated PVC sheathed cables.
IS 3975	-	Specification for Mild steel wires, strips and tapes for Armouring cables.
IS 8130 & IEC 228 cables.	-	Specification of aluminium conductor for insulated
IS 5831 electric	-	Specification for PVC Insulation and sheath of cables

SYSTEM

Rated system voltage	-	11000 Volts
System grounding	-	Solidly grounded
Type of cable	-	Aluminium conductor, XLPE insulated, PVC Sheathed armoured power cable
Short time rating	-	18.3 KA For 1 Sec.
Depth of laying in ground	-	1000mm
Conduits	-	Space factor of not more than 60%
In trays	-	Single layer

SPECIFIC REQUIREMENTS

INSULATION LEVEL

The 11 KV cable will have a withstand voltage, impulse withstand voltage and partial discharge extinction level as per IEC 502.

CURRENT CARRYING CAPACITY

The cables shall have the current carrying rating as per IS when laid in conduit 1000 mm below ground level with the ground temperature being 35 degree C and air temperature being 45 degree C and assuming that thermal resistivity of soil is 150 deg C cm/w and a maximum operating temperature of 90 degree C.

SHORT CIRCUIT WITHSTAND CAPACITY

The cables shall withstand the short circuit current of 18.3KA for 1 second assuming an initial conductor temperature of 90 Degree C and a final conductor temperature of 25 Degree C.

DESIGN PARTICULARS

GENERAL

The power cables supplied under this specification shall be aluminium conductor XLPE insulated HRPVC sheathed and galvanished steel round wire armoured.

Adequate insulation shall be provided for the cables to operate continuously at the specified voltage with a high degree of safety and reliability throughout the life of cables. The sheathing material shall be of high quality PVC base compound.

CONSTRUCTION FEATURES

The cable shall consist of stranded aluminium conductors, conductor screened by extruded layer of semi-conducting material, which adhere properly with the XLPE (cross linked polyethylene) insulation during cross-linking.

The conductor screen, insulation and insulation screen will be extruded during a single operation. Cross-linking will be preferably by dry gas curing process.

Copper tape screen, followed by copper tape, cores laid up together with central fillers, extruded inner sheath of heat resisting grade PVC, suitable for an operating temperature of 85 Degree C (Type 4, IS 5831 – 1970), taped with polyal, PE sheathed. The 3 core cable will be provided with galvanished single steel wire armouring and an overall outer sheath of extruded PVC sheath suitable for an operating temperature of 85 degree C (Type ST2, IS 5831 – 1984)

CONDUCTOR

The conductor shall be composed of hard drawn high conductivity Aluminium wire complying with IS : 8130-1976.

The conductor shall be smooth, uniform in quality and free from scale, inequalities, spirals, splits and other defects. Conductors shall have appropriate dimensions and resistance as per relevant IS. Number of strands and strand dia. of cable shall be indicated.

The stranded conductor shall be free from sharp edges shall have compacted circular in shape with smooth surface.

CONDUCTOR SCREEN

The conductor screen consists of a layer of smooth black extruded semi – conducting XLPE compound firmly bonded with the insulation. This eliminates electrical discharges at the interface between conductor and insulation.

INSULATION SCREENING

Extruded semi conducting compound followed by helically wrapped 0.050mm thick copper tape.

OUTER SHEATH

Extruded outer sheath shall be provided over the armouring. The material using for sheathing shall be PVC type ST2 as specified in I.S. for power cables. The colour of the outer sheath shall be black. The thickness of the outer sheath shall be as per relevant standards.

TESTS

All the tests specified below including repeated tests shall be carried out in accordance with the relevant Indian Standards by the manufacturer in the presence of Client / Consultant representatives.

ROUTINE TEST

- Resistance test for conductors
- High voltage test
- Partial discharge test

ACCEPTANCE TEST

- Tensile test for Aluminium.
- Wrapping test for Aluminium.
- Conductor Resistance test.
- Test for thickness of insulation and sheath.
- Partial discharge test
- Insulation resistance test.
- High voltage test
- Hot set test for insulation
- Tensile strength and Elongation at break test for insulation and sheath

TYPE TESTS

The following type tests shall be carried out on one sample in each size and type of cable taken out from the delivery lot.

- Tensile test for Aluminium
- Wrapping test for Aluminium
- Conductor resistance test
- Test for armour wires
- Test for thickness of insulation and sheath
- Physical test for insulation, inner and outer sheath
- Partial discharge test
- Bending test
- Dielectric power factor tests
- Impulse withstand test
- High voltage test
- Volume resistivity test
- Bleeding and blooming test for outer sheath
- Heading cycle test
- Flammability test

The sequence of test will be as per IEC 502 (Clause 16.1.1)

INSTRUCTION MANUALS

The manufacture shall furnish the following detailed literature with full specifications of the cables offered along with description of the manufacturer, work facilities and testimonials along with tender.

- General information
- Principal Technical data
- Description of insulation and sheathing
- Insulation and termination instructions

The supplier shall give his recommendations for handling, storage, laying and making joints and terminations for the cables in the form of instruction manual. The manufacturer along with the Test Certificate shall supply three copies of the instruction manual.

PACKING

The cable shall be packed and transported to site and ensure that no damage will be caused to the cable during transit. The drum number, date of manufacture and the size of the cable shall be mentioned on the cable drum.

CABLE DRUMS

Cables shall be supplied in specified steel/Wooden. Drums shall be non-returnable. The bidder shall indicate in the offer the maximum length of the cable, which can be furnished on one drum.

The drums shall be of heavy construction. All components shall be sound and free from defects that materially weaken the component parts of the drums. A metal preservation shall be applied o the entire drum. All ferrous parts used shall be treated with a suitable rust-preventive finish or coating to avoid rusting during transit or storage.

The cable ends shall be sealed with Raychem heat shrinkable caps.

One end of the cable shall be brought out of the drum and suitably clamped to the flange with proper mechanical protection. Location of the other end may be marked on the drum.

TECHNICAL SPECIFICATION FOR LV PANEL BOARDS

INTRODUCTION

This specification covers the design, manufacture and Supply, Integration, delivery and Supervision during testing & commissioning of LV Panel Boards (Form 4) incorporating ACB, MCCB, Capacitor, Metering and Protection.

The 415 V Switchboard shall be capable of continuous and reliable operation at the full load rating specified where continuity of operation is of prime importance.

The LV Breaker shall be capable of withstanding the severest stresses likely to occur in actual service and of resisting rough handling during transport.

Note: Integration includes supply of materials like Meters, CTs, Bus bars, Insulators, indicating Lamps, Metering Fuses, etc.,

STANDARDS

The Tenderer shall control the quality of items and services to meet the requirements of this specification, applicable codes and standards and other procurement documents.
The LV Panel Boards shall comply with the latest issue of the following standards.

IS 8623 – General requirement for factory built assemblies up to 1000 Volts.
IS 13947-2 – A.C. Circuit breaker requirements – Voltage not exceeding 1000Vs Part I & II, Sec 1 and IEC 60947 part I & III
IS 2705 – Specification for current transformers
IS 1248 – Specification for direct acting electrical indicating instruments.
IS 3156 – Voltage transformers
IS 3231 – Relays
IS 13703 – Specification for HRC cartridge fuse links upto 650 Volts
IS 11353 – Marking and identification of conductors and apparatus
IS 13947 – Part I & II – Moulded Case Circuit Breaker
IS 6005 – Code of practice for phosphate Iron and Steel
IS 5082 – Wrought Aluminium & Aluminium Alloy for Electrical Purposes

CONSTRUCTION

The LT Panels shall be of Metal enclosed, indoor, floor mounted self standing type, compartmentalized, top entry and single front connected.

Made up of the requisite vertical sections, which when coupled together shall form continuous dead front switchboards.

The indoor LV Panels shall be of dust and vermin proof of MS sheet steel enclosure with degree of protection IP 52.

Readily extensible on both sides by the addition of vertical sections after removal of the end covers.

The panels shall be constructed only of materials capable of withstanding the mechanical, electrical and thermal stresses as well as the effects of humidity, which are likely to be encountered in normal service.

Each vertical section shall comprise: -

A front-framed structure of rolled/folded sheet steel channel section, of minimum 14SWG thickness, rigidly bolted together. This structure shall house the components contributing to the major weight of the equipment, such as Air circuit breaker cassettes, MCCB's, main horizontal bus bars, vertical risers and other front mounted accessories.

The structure shall be mounted on a rigid base frame of folded sheet steel of minimum 3mm thickness and 100mm height. The design shall ensure that weight of the components is adequately supported without deformation or loss of alignment during transit.

The design shall ensure generous availability of space for termination and maintenance of cabling, and adequate safety for working in one vertical section without coming into accidental contact with live parts in an adjacent section.

A cover plate at the top of vertical section, provided with ventilating hood where necessary aperture for ventilation shall be covered with a perforated sheet to prevent entry of vermin.

Front doors and rear covers fitted with dust excluding synthetic rubber gaskets with fasteners designed to ensure proper compressions of gaskets. When covers are provided in place of doors, generous overlap shall be assured between sheet steel surfaces with closely spaced fasteners to preclude the entry of dust.

The height of the panel shall not be more than 2100mm. The total depth of the panel should be adequate to cater for proper cabling space and shall not exceed 1200mm for ACB sections.

Doors shall be minimum 14SWG sheet steel. Sheet steel shrouds and partitions shall be of minimum 16SWG thickness. All sheet steelwork forming the exterior of switchboards shall be smoothly finished, leveled and free from flaws. The corners should be rounded.

All insulating material used in the construction of the equipment shall be of non-hygroscopic material, duly treated to withstand the effects of high humidity, high temperature tropical ambient service conditions.

Metallic / Insulated barriers / Hylum Shrouding shall be provided within vertical sections and between adjacent sections to ensure prevention of accidental contact.

All doors/covers providing access to live power equipments circuits shall be provided tool operated fasteners to prevent unauthorized access.

Provision shall be made for permanently earthing the frames, doors and other metal part of the switchgear by two independent connections.

Operating devices shall be incorporated only in the front of the switchgear. No handle shall be located more than 450mm and not higher than 1800mm above finished floor level.
It shall be possible to extend the switchgear in either direction, whenever required. End of bus bars shall be suitably drilled for this purpose.

Suitable eyebolt for lifting of panel shall be provided.

BUSBARS

The bus bars shall be air insulated and made of high conductivity, high strength, 99.99% Pure Electrolytic grade Aluminium.

A current density of 0.8 A / Sq. mm. shall be considered for Aluminium bus bars. For Main MV panel the size of 3200A bus bars shall be designed on the basis of a short circuit rating of 50KA for 1 sec and for other sub panel boards the bus bars shall be designed for 35KA and 25KA correspondingly.

The bus bars shall be suitably braced with non-hygroscopic SMC supports to the neutral as well as the earth bar should also be capable of withstanding the stress of electrical fault. Ridges shall be provided on the SMC supports to prevent tracking between adjacent bus bars.

As per standards large clearances and Creepage distances shall be provided on the bus bars system to minimize the possibility of a fault.

High tensile bolts and spring washers shall be used to minimize the possibility of a fault.

Connections from the main bus bars to functional circuits shall be arranged and supported so as to withstand without any damage or deformation the thermal and dynamic stresses due to short circuit currents.

Apparatus forming part of the panel shall have the following recommended minimum clearances for an insulated bus bars or should as per relevant IS code 4237 – 1967.

Between phases – 25mm
Between phases and neutral – 25mm
Between phases and earth – 19mm
Between neutral and earth – 19mm

Bus bars shall be color coded for easy identification of individual phases and neutral with heat shrinkable PVC sleeves.

For lengthy bus bars suitable expansion joints shall be provided.
The main bus bar shall have uniform current ratings through their length. The current rating of the neutral shall be half of the size that of the phase bus bars throughout the length of the switchboard. However for the UPS Panels, the Neutral Bus bars shall be Double the size of Phase bus bar. Removable neutral links shall be provided on feeders to permit isolation of the neutral bus bar.
The bus bar and supports shall be capable of withstanding 50 KA Short circuit current at 415 V for 1 Sec in the Main distribution board and 35KA for Sub

distribution boards above 250A up to 800A rating and 25KA for up to 250A. Only zinc passivated or cadmium plated high tensile strength steel bolts, nuts and washers shall be used for all bus bar joints and supports. All bus bar supports shall be SMC only.

All bus bars shall be colour coded by means of identifying colour rings at every power tap off point. Red, yellow and blue colour shall be used for Phase bus bars and Black colour shall be used for neutral bus bars. Each bus bar shall be insulated with heat shrinkable colored PVC sleeves.

The Bus bars shall be capable of withstanding rated capacity without any deration at 70°C.

The rating of bus bars shall be same as that of incomer breaker rating.

Bus bars shall be housed in a separate chamber, which shall be accessible for inspection when it is required.

POWER CONNECTIONS

Interconnection of various switchgear components with the main bus bars shall be done with connection adaptors, component adaptors & connection clamps. The adaptors shall be directly mounted on the bus bar. Adaptors to be tightened to the recommended torque for a firm & reliable connection, using specified tools or just latched on the bus bar. Switchgear components to be mounted on the adaptor or separately on the mounting plate. The adaptor shall be of fiberglass-reinforced thermoplastic polyester (PBT), with continuous maximum operating temperature of 140°C, complying with UL 94-V0 fire protection (i.e. self extinguishing within 5 sec.) The cable entry shall be top / bottom as per BOQ.

All components (Bus bars, connection adaptor, component adaptor, supports, switchgear components etc.) shall be mounted based on open system.

Terminal blocks to be adequately provided to take outputs from the switchgear components, with suitable size of cable.

Individual tap-off connections from the bus bar shall be done with sheet – steel zinc plated, passivated or brass connection clamps or plates. The tap-off clamp shall be shrouded with system covers of ABS material, complying to UL 94-V0 fire protection (i.e. self extinguishing within 5 sec.) For currents above 125A up to 1250A bus bars shall be used of respective rating. The bus bar shall be of high-purity electrolyte Aluminium F20. The insulation shall be of high-strength vinyl compound with expansion of 370% & operating temperature range of –30° C to + 105° C. Flame retardant version of L 94-V0 (i.e. self extinguishing within 5 sec.) & dielectric strength of 20KV/mm.

Interconnection between bus bars shall be done with bus bar connectors of sheet steel, yellow passivated (top) & silver plated E-Cu (bottom) material.

TECHNICAL SPECIFICATIONS FOR DMC / SMC

PROPERTIES	UNITS	TEST METHODS (ASTM)	VALUES	
			SMC	DMC
PHYSICAL				
Specific Gravity	gm/cc	D-792	1.7	1.9
Glass Contents	%	N.A	25	15
Water Absorption	%	D-570	0.2	0.15
MECHANICAL				
Tensile Strength	Kg/Sq. cm	D-638	700	400
Flexural Strength	Kg/Sq. cm	D-790	1550	900
Compressive Strength	Kg/Sq. cm	D-695	1800	1500
Impact Strength	Kg cm / Sq. cm	D-256-A	60	25
ELECTRICAL				
Dielectric Strength	KV/mm	D-149	12	10
Tracking Index	Volts	BS-5901	+600	+600
Arc Resistance	Secs.	D-495	+800	+800

COMPONENTS

I. AIR CIRCUIT BREAKER

ACB shall confirm to 60947 (Part I & III) / IS 13947 (Part I & III)

Suitable for a service voltage of 3 Phase, 415 V minimum, 50 Hz AC supply and shall have an insulation voltage of 1000 V.

Possible to upgrade the degree of protection of ACB to IP : 54. Minimum degree of protection of the ACB shall be IP : 43.

Suitable for front and rear access.

The microprocessor based Relay shall comply with IS 13947-1 for general rules and IS 13947-1 for standards pertaining to contactor shall be designed for AC3. It shall be suitable for Type 2 coordination as per suitable clause in the relevant Indian Standards.

The microprocessor based Relay shall be capable of offering differential protection and shall be ambient compensated type, operable upto 70 °.C.

The microprocessor based Relay shall be capable of withstanding short circuit equal to seventeen times the rated thermal current (17 Ie).

The microprocessor based Relay should have built in single phasing protection and phase unbalance protection as per IEC947-4.

The ACB shall be provided with 4 NO & 4 NC auxiliary contacts.

INTERLOCK AND SAFETY ARRANGEMENT

The ACB's shall be Three-Pole / Four pole draw out type. Any attempt to with draw the Air Circuit Breaker, when the unit is in service, will automatically trip the breaker. It shall be possible to rack the ACB to disconnected position with the door closed.

Remote electrical indication of the circuit breaker status should be possible for all the positions.

Possible to close the ACB electrically and the spring charging time shall be preferably by less than 5 seconds. The mechanism shall be of stored energy type. The electrical closing mechanism shall have a built- in anti pumping feature minimum 6 NO & 6 NC control contacts should be available for external use.

RATING AND BREAKING CAPACITY

The ACB shall have Minimum Service Breaking Capacity (Ics) equal to Ultimate Breaking Capacity (Icu).

The Minimum Service Breaking Capacity (Ics) for 2000 AMPS is 55 KA.

PROTECTION

There shall be an option to select the curves (minimum 80 combinations) and also change the operating time for minimum of 8 settings for overload, 7 for short circuit and 7 settings for earth fault.

There shall be facility for selecting various type of E/F protection if required.

Trip history feature shall be available.

Neutral protection of 50 to 100% shall be available.

Self - diagnostic malfunction alarm for microprocessor should be available.

"The trip unit shall have thermal memory.

I^2 t cropping facility shall be available for short circuit and earth fault.

Facility should be there to monitor the load and intimate a pre-trip alarm or have load-shedding feature.

Fault indication by means of LED should be available for Overload, Short Circuit and Earth Fault and also LCD display for indication of menu's, settings, recorded information.

Trip reset facility should be manual / automatic.

It shall be possible to trip (or) close the Breaker through RS 485 communication interface.

II. Moulded Case Circuit Breakers

MCCBs should comply with IEC 947 Part 2. / IS 13947

The MCCB shall be suitable for universal mounting (i.e) the Load / Line must be interchangeable.

The MCCB shall be suitable for operating Voltage of 415 V minimum and an Insulation Voltage of 690 V.

Rating and Breaking Capacity

The Service Breaking Capacity (Ics) in KA for MCCB shall be as follows: -

35 KA for all MCCBs above 250A up to 630A. Ics = Icu

25 KA for above 63A and up to 250A in Sub Panels Ics =Icu
16KA for UPTO 63A in Sub Panels Ics =Icu

However Ics value is only deciding factor

PROTECTION

Overload and short circuit setting details:-

All outgoing MCCBs in the Main distribution boards and incoming MCCBs of all Sub distribution panel boards shall be of adjustable overload and short circuit protection settings.

The outgoing MCCBs in the Sub Panels needs adjustable thermal overload settings only and fixed short circuit setting.

The Thermal setting shall be adjustable from 40% to 120% of its normal current.

The magnetic setting shall be continuously adjustable from 5 to 10 times of its set current.

Trip reset should be available Manual / Automatic.

III. CONTACTORS

Contactors shall comply with IS 13947 for general rules and IS13947-4-1 for standards pertaining to contactors and motor starters. The contactor shall be capable of withstanding breaking & making capacities as follows:

AC3 Category

Making Current - 10 times Rated Current
Breaking current - 8 times Rated current

Contactor shall be capable of withstanding an impulse voltage of 8KV and have an insulation voltage of 1000V.

The Contactors shall be capable of frequent switching and should operate without any deration at 55 ° C for AC3 application.

The coil shall have 3 terminals and the insulation class shall be preferably H class, to sustain frequent switching operations. The auxiliary contact block shall have a switching capacity of 240V at 2A.

Contactors shall have one auxiliary in-built and it shall be possible to have additional NO & NC contacts in steps of two.

The contactors for the capacitors shall be of capacitor duty.

IV. THERMAL OVERLOAD RELAY

The Thermal Overload Relay shall comply with IS 13947-1 for general rules and IS 13947-1 for standards pertaining to contactor shall be designed for AC3.

The Thermal Over Load Relay shall be suitable for and Type 2 coordination as per suitable clause in the relevant Indian Standards.

The Thermal Overload Relay shall be capable of offering differential protection and shall be ambient compensated type, operable up to 70 ° C.

The Thermal Overload Relay shall be capable of withstanding short circuit equal to seventeen times the rated thermal current (17 Ie).

The Thermal Overload Relay will be tripping class 10A as a standard or class 20 for certain applications where specified.

The Thermal Overload Relay should have built in single phasing protection and phase unbalance protection as per IEC947-4.

It shall be possible to mount the Thermal Overload Relay on the underside of the contactor directly.

The design of the terminal shroud shall be such that it offers complete protection against direct finger contact with the power terminal, as under IP 20 protection.

The Thermal Overload Relay shall have in built 4NO & 4NC contact.

The “Reset” operation shall be clearly distinguished from the “Stop” operation.

The Thermal Overload Relay shall have separate “Stop” and “Test” button.

The setting shall be of the adjustable type and there should be a provision of sealing to make the same tamper proof.

The Thermal Overload Relay shall be suitable for Aluminium termination, with a maximum permissible temperature rise of 65K, at the terminals, with an ambient temperature of 40 °. C.

Capacitor Duty Contactors of adequate rating should be provided for the capacitor bank controls and substantiating the ratings selected.

WIRING

Power, control, signaling, protection and instrument circuits shall be done with PVC Insulated FRLS multi strand copper conductors. The insulation grade for these wires shall be 1100 volts. All control wiring shall preferably be enclosed in plastic channels or neatly bunched together.

For 16 AMPS control MCB, 2.5 Sq. mm size wires shall be used. Each wire shall be terminated at a separate terminal. Termination of two outgoing wires on a single terminal will not be acceptable. Wires shall not be joined or tied between terminal parts. Shorting links shall be provided for all C.T. Terminals.

Each wire shall be identified at both ends by self-sticking wire marker tapes or PVC Ferrules. Ferruling of wires shall be as per relevant IS.

A minimum of 10% spare terminals shall be provided on each terminal block. Conductors shall be terminated with adequately sized compression type lugs. "ELMEX" (direct conductor termination) type terminals will be acceptable for wires up to 10 sq. mm.

The control terminals shall be mounted in such a way that they are separate from the power terminals and shall be easily accessible without any hindrance from the power circuitry.

The wiring shall be complete in all respects so as to ensure proper function of control, protection and interlocking schemes.

CURRENT TRANSFORMERS

Current Transformers shall be tape wound for feeders up to 200A and cast resin insulated type for feeders rated above 200 A. The CT ratio and VA burden shall be such that it can power all meters.

Current transformers shall generally conform to IS: 2705.

Current transformers for instruments shall have an accuracy class 1.0 for MV Panels and accuracy limit factor less than 5.0. The current transformers shall be capable of withstanding the peak momentary short circuit current for 1.0 second. The neutral side of the current transformers shall normally be earthed through a link.

MEASURING INSTRUMENTS

All measuring instruments shall be of flush mounting, digital type and the size of indicating instruments shall be 96 x 96 Sq. mm.

A.C. 3 Phase digital type Multifunction meter (A,V,KW,KWH,HZ) shall be provided for all the incoming breakers.

Control and selector switches shall be CAM operated rotary switches

INDICATING LAMPS

Indicating lamps shall be of LED type, low watt consumption, provided with series resistor where necessary and with translucent lamp covers. Bulbs and lenses shall be easily replaceable from the front.

All MCCB required ON OFF TRIP Indications.
Following Indicating Lamps are required on the panel having lens colours as detailed below :

RYB Indication Lamps :	RED, YELLOW, BLUE	
Breaker ON	:	RED
Breaker OFF	:	GREEN

Auto Trip : AMBER

RELAYS

All protective relays shall be of numerical type, suitable for flush mounting and fitted with dust tight covers. All relays shall be mounted on the front of the panel and shall be specified as per requirement. The current and the voltage coils shall be provided as specified.

All relays shall have built-in flag to indicate operation. It shall be possible to reset the flag without opening the relay case. All tripping relays shall be suitable to operate on the specified voltage.

Transformer protection relays such as Two Over current & one Earth fault relay similar to CDG - 31 with instantaneous trip shall be provided with following Plug setting O/L 50-200% and E/F 20-80% relay.

It shall be possible to trip (or) close the Breaker through RS 485 communication interface.

LIGHTNING & SURGE ARRESTORS

LIGHTNING PROTECTION FOR MAIN MV PANEL

The Incoming supply of the Main MV Panel shall be protected by suitable encapsulated spark gap type lightning arrestor to take care of 35-50KA / Pole of 10 / 350 Micro second of Lightning surges for each phase to neutral and 100-125KA / Pole of 10 / 350 Micro second of Lightning surges for neutral to earth.

LIGHTNING & SWITCHING SURGE PROTECTION FOR SUB PANELS

The power supply of all the sub distribution panels shall be protected by suitable lightning arrestor to take of 7KA / Pole of 10 / 350 Micro second of lightning surges for each phase to neutral and 25KA / Pole of 10 / 350 Micro second of lightning surges for neutral to earth. In addition the surge arrestor should also be capable of handling a nominal discharge current of 30KA / Pole of 8 / 20 Micro second of switching surges a maximum discharge current of 50 KA / Pole of 8 / 20 Micro second of switching surges. It should be a plug in type arrestor with a dynamic separating device.

CABLE TERMINATIONS

The cabling chamber of adequate size for accommodation, support and termination of Copper / Aluminium cables shall be provided at the rear.

Ample space for connection of the cables shall be provided front / rear of the switch board. The cable termination arrangement shall be of adequate size and design to receive the required number of cables as required. Proper clamping cable clamping arrangements shall be provided.

Detachable gland plate of 5 mm thickness shall be provided for the cable entry into the panel. Sufficient space shall be provided to avoid sharp bending and facilitate easy connection. Suitable shrouds shall be provided to prevent accident contact with live outgoing terminations of other feeders while carrying out maintenance on one feeder.

LABLES

Every switchboard, switchboard control contactor, time switch, relay, indicator lamp, meter, motor starter, link and any control or protection equipment within or on a switchboard shall be clearly and accurately labeled.

Labels shall be engraved laminated plastic or photo anodized rigid aluminum and shall comply with the following requirements.

Except where otherwise required labels shall be fixed adjacent to, but not on any item of equipment.

Engraved lettering shall be white on a black background, except that the label for a main switch shall have red lettering on a white background, and warning and caution labels shall have white lettering on a red background.

Labels shall be securely fixed by Screws and adhesive, are fixed in an extruded aluminum section which shall be countersunk screw fixed or countersunk riveted to the panel. Screws shall be tightened with nuts or into tapped holes in the switchboard. Mechanically expanded plastic rivets of minimum 6 mm. head diameter are acceptable instead of screws. Aluminum rivets may be used to fix

aluminum labels only. Self – tapping screws, thread – cutting screws or other fixing are not acceptable.

LABELS ON EXTERIOR OF SWITCHBOARDS

All switchboards shall be labeled with the manufacture's name.

A switchboard designation label shall be provided. Engraved letter shall be Black background with white lettering. For other than main switchboards, the designation label shall also state the source of electrical supply. Separate sections of enclosures shall be identified. The label for any section or enclosure containing supply Authority equipment shall be to the satisfaction of the Client / Consultant.

Every switchboard control shall be labeled and shall include:

Circuit designation for all main switches, main controls and sub main controls.

Details of the Consumer's mains and all sub mains.

Incoming bus bar or cable rating.
The minimum height of lettering shall be 6mm.

EARTHING

Switchgears in the panel shall be provided with double earth connection of size indicated in the schedule and connected to the earth bus.

Earth bus bar shall be supported at regular intervals.

All instruments and metering panel doors shall be connected to earth by using 2.5 sq. mm. 650V, FRLS PVC multi stranded copper conductor or flexible braided copper wire of equivalent size and directly connected to the earth bus of the panels

The materials and size of the earth bus bar shall be as specified in the BOQ.

At either end of the earth bus provision shall be made for bolting the earth bus to the earth electrode with nuts & bolts and spring washer. The earth bus bar shall run along the entire length of the board.

PAINTING

The painting process shall be using a seven-tank phosphating system. All metal surfaces shall be chemically cleaned, degreased and pickled in acid to produce a smooth clean surface, free of scale, grease and rust.

After cleaning, phosphating and passivation treatment, the surface shall be given to the powder coating of paint shade of RAL 7032 in light gray. Sufficient quantity of touch up paint shall be furnished for application at site.

GENERAL

Inter panel partitions / barriers in sheet steel are required to be provided.

Bus bar joint shrouds are required to be provided and shall be of clip – on type reusable so that it can be easily removed and refitted.

All internal wiring shall be done with crimping type lugs and all terminals are to be identified / feruled properly.

All vacant compartments above 100mm to be provided with earth strip.

“Danger” labels on rear doors shall be provided.

Necessary terminals are to be provided for BMS interface at all Panels.

Data sheet shall be referred for specification of the ACB & MCCB to be used in panels.

No alterations drill holes welding etc., are to be done at site after the panel boards are received from the factory.

The **LV** panel boards shall complete with all rules & regulations as per CEIG norms and any modifications pointed out by them or any other statuary agencies after commissioning also to be carried out and completed at free of cost**.**

INSPECTION

Fully assembled Panel boards shall be offered for inspection at works. Materials shall be dispatched to site only after issuing the dispatch clearance by the representative of client /consultants.

Stage 1 Inspection : During Assembly of Panel
Stage 2 Inspection : Before Dispatch

The readiness should be informed at least fifteen days before the proposed date of Inspection.

TESTS

The Panel design shall have undergone all the type tests as per IS: 8623. Type test certificate shall be submitted along with the panels.

VISUAL TESTS

Corrosion test
Paint inspection
Physical verification check
Rubber gasket test
Megger Test

ROUTINE TESTS

Routine test as per IS: 8623 on each completed switch boards shall be carried out in the factory and witnessed by client / consultants before dispatch and test certificates for the same shall be submitted.

Milli volt drop test on Rigid and expansion joints.
Temperature Rise Test.

COMMISSIONING

Pre-commissioning Checks and Tests shall be conducted at site by you at free of cost

and certificate shall be furnished.

The supplier shall render the service of his supervisor during the Installation and commissioning of the panels by other agency at free of cost.

The quoted price shall be inclusive of all necessary commissioning spares.

DRAWINGS AND MANUALS

Vendors shall furnish the following drawings for Client / Consultant approval before
fabrication of the panel.

Tenderer shall also provide detailed GA diagram, sectional drawings, control wiring diagram, Terminal drawings and other drawings with all dimensions indicating compartments cutouts, drill holes etc ., for all the panel boards to the Client / Consultant

Front and rear view of all switch boards indicating Switch Gear arrangements of various feeders/starters giving its location numbers and tag numbers for each as per single line diagram.

Typical control schematic diagram for each type giving type designation to be referred on Single line diagram.

Switch board foundation/fixing details with all dimensions and details of shipping sections.

All the catalogues, manuals pertaining to each and every ACB, MCCB, Meters, Relays, and CTs etc. should be sent along with the panel boards.

Bill of Materials used in panels indicating the make of each items

Manufacturers and service providers address, contact person, contact no etc., has to be sent to us for all the components.

SPARES AND TOOLS

The commissioning and maintenance spares required for installing the LV Switch board
shall be quoted separately.

The tools required for the LV Switch boards also listed and quoted separately.

TECHNICAL SPECIFICATION FOR APFC WITH DETUNED FILTER PANEL

INTRODUCTION

The design, manufacturing, testing and performance of the Automatic power factor correction with detuned filter panel and components there off, included in this specification shall comply with all currently applicable Indian Standards & IEC standards and specific standards and codes specified in the design data sheets.

GENERAL REQUIREMENTS

CAPACITOR UNIT

Capacitor unit shall be self-contained with rating as indicated in data sheets. Each capacitor unit shall have a proper name plate. Each capacitor element shall have individual fuses.

CAPACITOR BANKS

Capacitor bank shall consist of individual capacitor units with supporting insulators, steel racks assembly, busbars connectors mounting channels, frame etc. If capacitor bank is located outdoor the rack and the associated hardware shall be hot dipped galvanized.

When specification calls for capacitor bank and associated accessories to be metal enclosed, such panels shall have adequate ventilation with louvers covered

with brass mesh. Individual capacitors unit and the cubical shall be earthed to separate earth bus in case of non-effectively earthed system.

(i) Capacitor should be sustained 525V, +/-10% respective to cope with harmonics and over voltage conditions.

(ii) Inrush current withstanding capacity of 1.5 times Ir and 2 times Ir for harmonics types.

DISCHARGE DEVICE

LT capacitors discharge resistance shall be externally mounted.

POWER FACTOR IMPROVEMENT PANEL

The panel shall be designed as per the relevant Indian Standards. The capacitors shall be polypropylene, double layered type. Automatic power factor correction panels shall be suitable for 433V system. The LT capacitors shall be controlled by magnetic contactors and shall have their control through the APFC panel.

The APFC panel shall be totally enclosed, fully compartmentalized, fixed type, free standing, sheet fabricated dust and vermin proof, dead front type in single front utilized construction having feeders compartments in tier formation to form vertical panels. All the meters switches lamps protective relays shall be housed on the front panel and the cable alley compartments shall be besides feeder compartments.

Suitable exhaust fans shall be provided to remove the heat generated by the capacitors.

Doors of all the switchgears shall be of gaskets to prevent entry of lizards, rats and dust.

The 3 phase / neutral main shall be extended through all the units of the APFC panel line up. The main busbars shall be of uniform section throughout and shall be sized to continuously carry the rated current without exceeding the temperature rise of 20 deg. C over the ambient and shall be capable of withstanding the full fault current without any deformation. The rating of the busbar shall be the same as the Incomer breaker rating. The busbars shall be either electrolytic copper or Aluminum with proper plating at the joints. The busbars shall be PVC sleeved and colour coded. The neutral busbars shall be 50% of the phase busbars and shall be insulated from the structure.

A continuous ground bus running through all the compartments and solidly connected shall be provided. The ground bus shall be at least 25 x 3 mm copper or equivalent aluminum. Two earthing connections shall be provided for connection to external earthing network of plant.

Control signaling protection and metering wiring shall be PVC insulated 1.1 KV grade copper conductor wires of minimum 2.5 sq. mm. Wiring shall run in enclosed channels and shall leave at least 25% space for future use. Wires for connection between the moving parts shall be of stranded copper. The terminal block shall be Elmax plug type of adequate size, conveniently located for easy accessibility. All spare contacts from equipments shall be wired up to the terminal block.

All 415V circuit breakers shall be MCCB's with manual and power operation. Sufficient number of auxiliary contacts, shunt trip device, position indicators, operation counters local / remote switches etc. The circuit breakers shall have current rating of at least 1.5 times the full load of the circuit.

The isolators shall be heavy-duty type equipped with auxiliary contacts and quick make type. The operating handle shall be on door and interlocked to the ON

position. Fuses shall be HRC cartridge type with rupturing capacities not less than full fault level on the busbars.

Contactors shall be magnetically held air break type. They shall be provided with 3 main contacts, one hold on contact and at least two NO + NC auxiliary contacts. The contactors shall have current rating of at least 1.5 times the full load of the circuit and shall be capable of carrying the full fault current without welding. The coils shall be rated for 240V AC and shall work satisfactorily between + 10% and – 15%.

Protective relays shall be of reputed make as specified in approved makes, preferably inbuilt SR XI type.

Indicating lamps shall permit replacement from the front.

Provision shall be made for addition of future panels on either side of all the panels.

On APFC panels at least one fully equipped spare unit shall be provided and in general 10% empty compartments shall be left for future use.

Following indicates bare minimum requirements of each typical feeder. For individual applications final provisions have to be detailed out and whatever specific material relays, auxiliary relays, timers, meters and devices required for APFC Panel.

INCOMING FEEDER

- One no. 630A TP Heavy duty double break isolator and all accessories for normal operation, auxiliary contacts, test, ON/OFF switch, position indicator respectively.
- One set of TPN air insulated, PVC sleeved rated busbars.
- One no. Voltmeter with selector switch.
- One no. Ammeter with selector switch.
- One set of LED type RYB indication lamps with control MCBs.
- 10/12 Stage Automatic Power Factor Correction relay.

- Auxiliary relay, harmonic filters,wiring fuses, terminals and devices as may be required.

CAPACITOR BANK FEEDERS

- One set duty rated, TPN, air insulated, PVC sleeved busbars.
- One duty rated MCCB with handle.
- Two red / green lamps for ON / OFF indication.
- One set of fuses with base.
- One no. capacitor duty air break contactor.
- ON & OFF push button.
- Detuned Reactor.
- Capacitor 100/50/25 KVAR as required.

INSPECTION AND TESTING

This shall be carried out based on the latest revision of this specification and approved vendor drawing certified for construction. In case of any ambiguity between the vendor drawings and order specification, the requirement indicated in technical specification shall govern.

Client shall have the right to carry out stage inspection.

All routine and type tests as specified in the relevant IS shall be carried out during the final inspection.

Vendor shall ensure that the meters associated with the testing equipments are calibrated and are valid at the time of testing.

GUARANTEE

The performance figures indicated in the data sheet shall be guaranteed within the specified or as permitted by relevant standards. In case of failure of the

equipment to meet the guaranteed performance, purchaser reserves the right to use provided material until the new equipment meeting the guaranteed performance is supplied to the vendor.

In case of failure of any unit, the vendor shall replace the unit with a new piece.

DESIGN DATA SHEET

RATING	: 50 KVAR
BANK CONNECTION	: Delta
EARTHING	: 2 Studs
INITIAL PF	: Lag
CORRECTED PF	: Lag
DIELECTRIC FOR	: All Polypropylene
Continuous over voltage withstand value	: 110 %
Over load capacity	: 135 % of rated value banks

FUSES

Type	: HRC catridge non Deteriorating
Applicable standard	: IS 9224 – part 2
Mounting	: Internal
Category of duty	: AC - 3

DISCHARGE RESISTANCE

Discharge time	: Less than 50 seconds.

TECHNICAL SPECIFICATION FOR DISTRIBUTION BOARD

SCOPE

This specification covers the design, manufacture, assembly, testing and supply of Distribution Boards. Manufacture and finish shall be completed at the works.

CONSTRUCTION

The MCB distribution board shall comprise of all welded fabricated out of 1.6mm thick sheet steel case and door of robust and rigid construction, designed to exclude dust and vermin proof. The hinged door should be secured by robust fasteners, enabling dust-protecting gasket to be compressed quickly and easily.

The operating handle of the switch and the operating knobs of the miniature circuit breaker shall be projecting outside the cover plate. Protective insulated cover plate shall be provided inside the boards to cover all the live parts. The incoming MCB terminals shall be suitably covered to avoid accidental contact. The boards shall be factory assembled, painted and wired.

The phase segregation partitions with double door arrangements shall be provided in the distribution boards. The distribution board shall be provided with undrilled detachable end plates at the top and bottom and shall be completed with suitable wall fixing arrangements.

BUSBARS

The bus bar shall be air insulated and made of high conductivity copper bus bars suitably sized for the required rating. The neutral bus bar shall be the same size of phase bus bar. The neutral bus bar shall adequate number of terminals for all outgoing single-phase circuits. The earth bus provided in the distribution board shall have the suitable size of copper bus.

MINIATURE CIRCUIT BREAKER

The MCB shall fully comply with latest standard IS 8828 – 1996 / IEC 898-1995 or equivalent standard. MCB shall comply with Isolation function as per IEC 947-3. The MCB shall have all auxiliary devices like shunt trip, auxiliary contacts, under voltage etc. The maximum breaker rating shall be 125A.

MCB for ratings upto 125A shall be available in 1,2,3 or 4 Pole versions. MCB casing shall be made of self-extinguishing material tropicalised treatment.

The MCBs shall have inverse-time tripping characteristics against over loads and instantaneous trip against short circuits. The energy class of the MCB shall be of class 3 and of current limiting type. The losses of MCB shall be lesser than those specified in the standards.

The incoming and outgoing of the MCBs shall be accessible only after opening the front door of the MCB DB.

EARTH LEAKAGE MINIATURE CIRCUIT BREAKER

The ELMCB shall fully comply with latest standard IS 8828 – 1996 / IEC 898-1995 or equivalent standard. ELMCB shall comply with Isolation function as per IEC 947-3. The enclosure of the ELMCB shall be mounted from High quality insulating materials, which shall be fire retardant, anti-tracking, non-hygroscopic, and impact resistant and shall withstand high temperatures.

The ELMCB shall be of current operated with sensitive of 100mA. The ELMCB shall have trip free mechanism and shall operate even on neutral failure. The ELMCB shall be provided with a Test push button to simulate leakage and test the ELMCB. The ELMCB shall operate and switch off the circuit with in 300 milli seconds incase of a fault.

EARTHING

Earthing stud terminals with suitable bolts, nuts and washers for connection to earth bus shall be provided on the outside of the distribution boards.

PAINTING

All metal surfaces shall be chemically cleaned, degreased and pickled in acid to produce a smooth clean surface, free of scale, grease and rust.

After cleaning, phospating and passivation, the surface shall be given two coats of zinc rich epoxy and baked in the oven.

After primer, it shall be given two coats of stoving type Epoxy powder coated paint in light grey color as IS – Shade.

INSPECTION

Fully assembled Distribution boards shall be offered for inspection at works. Materials shall be dispatched to site only after issuing the dispatch clearance by the representative of Client / Consultant.

The readiness should be informed at least fifteen days before the proposed date of inspection.

TESTS

The distribution boards shall have undergone to all types of routine tests and acceptance tests as per IS 8623.

DRAWINGS AND MANUALS

Vendor shall furnish the following drawings for Client / Consultant approval before fabrication of the distribution boards.

- General arrangement diagram, sectional drawings of the distribution boards.
- Distribution boards fixing details with all dimensions shall be furnished.

TECHNICAL SPECIFICATION FOR LV CABLES

SCOPE

This specification covers the Design, Manufacture, Testing at manufacturer's works and delivery by road at site properly packed in wooden drums of aluminium conductor XLPE insulated HRPVC sheathed armoured power cables and copper conductor PVC insulated, PVC Sheathed, armoured cables suitable for solidly grounded system as specified herein under.

The quantities indicated in the Bill of quantities are tentative only. Actual quantities to be procured will be decided after joint measurement at site.

STANDARDS

The cables covered by this specification unless otherwise stated are designed in accordance with the latest editions of the following standards.

IS 7098 - Specification for XLPE insulated PVC
(Part 1: 1977 Sheathed electric cables)

IS 1554 (Part -1) - Specification for PVC Insulated cables.

IS 5831 - Specification for PVC insulation and sheath of electrical cables.

IS 3975 - Specification for MS wires, strips and tapes for armouring cables.

IS 8130 - Specification for aluminium conductor for insulated cables.

IS 694 - Specification for PVC insulated cables for working voltages upto
And including 1100V.

IS 3961 - Recommended current ratings for cables.

TECHNICAL PARTICULARS

Rated system voltage - 415 Volts

System grounding - Solidly grounded

Type of cable - 1. Aluminium conductor, XLPE insulated, PVC Sheathed armoured power cable
2. Copper conductor, PVC insulated, PVC sheathed armoured cable

Voltage grade - 1100 Volts

No. of cores - Refer Schedule of quantities

Cables shall normally be laid under the following conditions:

In air : Ambient temperature of 45°.C
In ground : Ground temperature of 35° C
Depth of laying in ground : 1000mm
Conduits : Space factor of not more than 60%
In trays : Single layer, touching each other

Maximum conductor temperature for operation under normal rated current carrying conditions and under short circuit conditions are as follows:

Maximum conductor temperature & Standard Installation Conditions:

Maximum Conductor temperature at continuous load - 90°C

Thermal resistivity of soil 150°C cm/W

Thermal resistivity of XLPE 350°C cm/W

Thermal resistivity of PVC 70°C cm/W

DESIGN PARTICULARS

CONDUCTOR

The conductor shall be made of high conductivity plain annealed Copper / Aluminium wire complying with IS: 8130-1976.

The conductor shall be smooth, uniform in quality and free from scale, inequalities, spirals, splits and other defects. Control cables and power cables upto 16 Sq. mm size will have circular conductors. Other power cables can have sector shaped conductors. Conductors shall have appropriate dimensions and resistance as per relevant IS. No. of strands and strand dia. For each size of cable (Phase & Neutral) shall be indicated.

INSULATION

The insulation shall be of Cross Linked Poly Ethylene (XLPE) conforming to the requirements of Table 1 of IS 7098 (Part I) 1977 for the power cables and PVC (Type A) for control cables.

The average thickness of insulation when measured in accordance with IS shall not be less than the values specified therein. The cores shall be identified as per standard colour scheme for power cables. For control cables identification of cores with embossed / printed numerals will be required.

INNER SHEATH

The inner sheath shall be of thermo plastic materials Type ST2 as specified in IS 5831 for power cables and ST1 for control cables. Inner sheath will be applied by extrusion. The thickness of the inner sheath shall be as per relevant IS standards. It shall be possible to peel off the inner sheath easily, without damaging the core insulation during termination.

ARMOURING

The armouring arranged over the inner sheath shall consist of one layer of galvanized round steel wire for all control cables and smaller power cables. Power cables above 4 Core 16 sq. mm will have single layer of strip wire armouring. The armour wire being put on the cable shall conform to IS 3975 for all requirements. The direction of lay of armour shall be opposite to that of the cores. The Zinc coating on the galvanized steel wires will comply with relevant standards.

OUTER SHEATH

Extruded outer sheath shall be provided over the armouring. The material using for sheathing shall be PVC type ST2 as specified in IS 5831 for power cables and ST 1 for control cables. The colour of the outer sheath shall be black. The thickness of the outer sheath shall be as per relevant standards.

INSPECTION

The readiness should be informed at least fifteen days before the proposed date of Inspection for the purpose of witnessing the tests and to ascertain that the cable being manufactured conform to the requirements of this specification.

The entire test indicated in the test clause of this specification shall be carried out in the presence of Client / Consultant representative by the manufacturer.

Materials shall be dispatched to site only after issuing the dispatch clearance by the representative of client /consultants.

TESTS

All the tests specified below including repeated tests shall be carried out in accordance with the relevant Indian Standards by the manufacturer in the presence of Client / Consultant representatives.

ROUTINE TEST

- Resistance test for conductors.
- High voltage test.
- Partial discharge test.
- Conductor resistance test.
- Megger test.

ACCEPTANCE TEST

The following shall be carried out as acceptance test. These tests shall be carried out on samples taken out of 25 % of cable drums (in each size and type) in the delivery lot.

- Annealing test for Copper.
- Tensile test for Aluminium.
- Wrapping test for Aluminium.
- Conductor Resistance tests.
- Test for thickness of insulation and sheath.
- Partial discharge test
- Insulation resistance test.
- High voltage test
- Hot set test for insulation
- Tensile strength and Elongation at break test for insulation and sheath

INSTRUCTION MANUALS

The manufacture shall furnish the following detailed literature with full specifications of the cables offered along with description of the manufacturer, work facilities and testimonials along with tender.

- General information
- Principal Technical data
- Description of insulation and sheathing
- Insulation and termination instructions

The supplier shall give his recommendations for handling, storage, laying and making joints and terminations for the cables in the form of instruction manual.

Six copies of the instruction manual shall be supplied by the manufacturer along with the Test Certificate.

PACKING AND MARKING

The cable shall be packed and transported to site and ensure that no damage will be caused to the cable during transit. The drum number, date of manufacture and the size of the cable shall be mentioned on the cable drum.

The marking done on the drum with permanent marking shall have the following information:

- Trade name, if any
- Name of the manufacturer
- Number of cores and nominal area of the conductor
- Type of the cable and voltage for which it is suitable
- Length of the cable on the drum
- Direction of rotation of drum (an arrow)

CABLE DRUMS

Cables shall be supplied in specified wooden drums. The bidder shall indicate in the offer the maximum length of the cable, which can be furnished on one drum. The cable ends shall be sealed with Raychem heat shrinkable caps.

One end of the cable shall be brought out of the drum and suitably clamped to the flange with proper mechanical protection. Location of the other end may be marked on the drum.

TECHNICAL SPECIFICATION FOR CABLE TRAYS

SCOPE

The scope of work shall cover Hot Dip Galvanized heavy duty Cable trays, tray support systems, fittings and accessories for laying the power cables, control cables and teletechnical cables. Manufacture and finish shall be completed at the factory works.

CONSTRUCTION

The cable tray shall be manufactured to comply with the specifications of National Electrical code (NEC). The cable trays shall be of steel as per IS 226 and galvanized and the thickness of galvanization shall be not less than 100 microns. All bolts and nuts also be galvanized and shall confirm to IS 1363 – 60 for quality, threading and dimensions before galvanizing. Hot dip galvanizing shall confirm to IS 2633, Galvanizing of each member shall be carried out in one complete immersion. The galvanizing shall be uniform, clear, smooth, continuous and free from acid spots. The quality of Zinc used for galvanizing shall be 98.8% purity.

The cable trays and accessories shall be fabricated out of hot rolled steel sheets, which shall be hot dipped galvanized. The complete assembled cable tray sections shall be corrosion resistant, high strength and with extreme smooth surface.

CABLE TRAYS – TYPES

LADDER TYPE CABLE TRAYS

Ladder type cable trays shall be used for laying the power cables of medium voltage and low voltage. Ladder type cable trays shall be made out Channels for side rails and rungs.

Ladder type cable tray shall consist of a Welded rung assembly of field proven design. It shall consist of side rails of 3.0 mtrs. Standard lengths and slotted rung spaced 250mm center to center.

Coupler, Coupler fasteners, tray assembly fasteners must form the part of the equipment. The Ladders should be heavy duty sheet metal constructions yet robust enough to carry a cable load of 50 kg/m on a span of 1.25 mtrs.

The design shall be flexible enough to accommodate change of widths at site. Sections of 2mm shall be standard for different widths of trays as detailed in BOQ. Horizontal bends, Vertical internal / external, tees, crosses shall be standard products. Hinged or flexible coupler assemblies for Vertical / Horizontal route changes shall be available as standard as also reducers (offset couplers). Covers shall be of Pre-galvanized sheet 18 SWG (1.25mm up to 300w) & 16 SWG 1.6mm on higher widths) construction possible for easy mounting on to trays wherever applicable. Provision to add on earth flat holding clamps, trays fixing clamps should be part of cable tray design.

PERFORATED CABLE TRAY

Perforated cable trays shall be used for laying the cables of low voltage and control cable. Perforated cable trays shall be generally of channel type and the perforation in the trays shall be either 8 x 15 mm or 10 X 20 mm oval holes.

Perforated cable trays of 1.6mm thickness and standard lengths 2.5 mtrs as detailed in BOQ shall be offered by bidder if required. Finish shall be as specified earlier.

The data / voice cable shall be laid in the perforated type cable trays. Cable trays of 150mm and less than that shall be of perforated type only.

SIZES

The cable trays shall be of the following standard sizes.

Length : 3000 mm

Width : 150 / 300 / 450 / 600 / 800 / 1000 mm as required.

Height : 50 / 75 / 100 mm

Thickness of sheet steel: 2.0 mm / 3.0 mm as per width of tray.

The flange and width of the cable trays shall be decided based on the diameter and the number of cables running through each section of the cable tray.

ACCESSORIES

Cable tray manufacturer shall supply suitable accessories for clamping the cable trays on cable tray supports from ceiling and beams of the building structure. Cable trays shall be supplied with GI coupler plates, hardware, nuts bolts and washers for joining the standard lengths of cable tray section.

LOAD DEFLECTION CRITERIA

For tray system design in addition to self-load, following criteria shall be applied to determine section and thickness of cable tray as per the manufacturer's standards.

Support span 1500 mm

Cable load for 300 mm	50	Kg / m
Cable load for 400 mm	75	Kg / m

Cable load for 500 mm	85	Kg / m
Cable load for 600 mm	100	Kg / m
Cable load for 750 mm	110	Kg / m
Cable load for 1000 mm	125	Kg / m

In addition to this 70 Kg/m concentrated load at the center span shall be considered.
Allowable mid span deflection < 7 mm

GALVANIZING

Zinc confirming to grade Zn 98 of IS 209 shall be normally used for galvanizing. As far as practicable, the fabricated tray and accessories shall not be sunk to the bottom of the bath. Tray and accessories shall be galvanized at the lowest possible temperature, which will allow free drainage of zinc from the work piece during withdrawal. The thickness of the coating shall be minimum 100 microns. The zinc deposited shall not be less than approximately 720 gm / sq. mm. The thickness shall be checked by a magnetic method as per IS 3203.

Small components handed in baskets shall be centrifuged to remove excess of Zinc immediately after galvanizing while the coating is still in molten condition. Hardware such as nuts and bolts shall be Electro galvanized / zinc passivated.

TESTING AND INSPECTION

All the cable trays and accessories shall be offered for inspection at the fabricators works by client / consultant representatives. Physical inspection and tests will be conducted on the trays to check its compliance with the specification and approved drawings.

Elko meter shall be used to measure the thickness of galvanizing. Deflection load test at the manufacturer's works Test span shall be simple bream span with free unrestrained ends.

The cable tray shall be uniformly loaded along the span with cable tray simply supported at the two ends as per the load criteria. Vertical deflection of the tray shall be measured at the two points along the midway between the supports. The average of these two readings shall be considered to be the vertical deflection of the tray. Vertical deflection shall be within the design criteria.

EARTHING

The cable tray shall be provided with earth clamps at every 3000mm for connecting suitable copper strip / wire earth continuity.

TECHNICAL SPECIFICATION FOR INTERNAL WIRING SYSTEM

SCOPE

The scope of work under this section generally covers internal wiring for lights, exhaust fans, power sockets etc., The contractor shall provide all materials, labour, equipment, scaffoldings etc., as required for the completion of wiring installation called for. The wiring shall generally be done using PVC insulated copper conductor wires in M.S. conduit as called for including providing switches, sockets, plug tops, fan regulators, outlet boxes etc.,

STANDARDS APPLICABLE

The applicable standards for the above work shall be as listed below:

IS 732	-	Code of practice for electrical wiring installation.
IS 2667	-	Fittings for rigid steel conduits for electrical wiring.
IS 694	-	PVC Insulated cables.
IS 1293	-	Plug and sockets.
IS 8130	-	Specifications for conduits for electrical installation.
IS 3043	-	Code of practice for earthing.
IS 5216	-	Guide for safety procedures and practices in electrical work.
IS 4648	-	Guide for electrical layout in residential building.

SYSTEM OF WIRING

The system of wiring shall consists of single core PVC insulated copper conductor multi strand wires in MMS PVC conduits (IS marked) concealed.

GENERAL

Before laying of conduits, the Sub Contractor shall carefully examine the drawings indicating the layout of circuits, satisfy himself about the sufficiency of number and size of conduits, location of junction boxes, sizes and location of switch boxes and other relevant details. Any discrepancy found in the drawings shall be brought to the notice of the Main Contractor. Any modifications suggested by the sub-contractor shall be got approved by the Main contractor, before actual laying of conduits is commenced.

All necessary materials, including labour for installation of fixtures.

MATERIAL

CONDUIT

PVC conduit shall with ISI marked on all pipes at regular intervals. The minimum wall thickness shall be 1.6 mm for conduit up to 25 mm diameter and 2.0 mm wall thickness for conduits above 25 mm diameter and shall be ISI marked. No PVC conduits of less than 20 mm shall be used. The outer surface of conduit including all bends, union, tees, junction boxes etc. forming part of conduit system.

BENDS IN CONDUIT

Where necessary, bends or diversions may be achieved by means of bends and /or circular inspection boxes with adequate and suitable inlet and outlet connections. Incase of recessed system each junction box shall be provided with a cover properly secured and flush with the finish wall surface, so that the conductors inside the conduit are easily accessible. No bends shall have radius less than 2.5 times the outside diameter of the conduit. Cut ends of conduit pipe shall not have any sharp edges or any burns to avoid any damage to the insulation of conductor while pulling them inside pipes.

FIXING CONDUITS

Conduits and junction boxes shall be kept in position while the walls, slabs and floor are under construction and proper hold fasts shall be provided. Conduits shall be so arranged as to facilitate easy drawing of wire through them. Adequate junction boxes of approved quality and size shall be provided. Where conduits cross expansion joints in the building, adequate expansion fittings or other approved devices shall be used to take care of any relative movement. All conduits shall be installed so as to avoid steam and hot water pipes. Conduit in floor slabs shall be kept as short as possible above finished floor level in order to avoid any damage to them.

After the conduits, junction boxes, outlet boxes and switch boxes are installed in position, their outlet shall be properly plugged or covered so that water, mortar, insects or any other foreign matter does not enter in to the conduit system. At certain places installation of concealed conduit, accessories and switch / socket / grid plate / mounting boxes in woodwork and paneling will be required.

Where called for, surface conduits shall be fixed by means of spacer bar saddles at intervals not more than 800 mm and 200 mm from both sides of fitting or accessories.

The saddles shall be 3 mm X 19 mm galvanized mild steel flat, properly treated, secured fixed to support by means of raw bolts and brass machine screws. Conduit in chases shall be avoided. Where unavailable, conduit shall be fixed by means of staples not more than 600mm apart and the chases filled with cement mortar 1:4. Cutting of horizontal chases is prohibited. All socket connections shall be made fully water tight by the suitable adhesive cement for PVC conduits.

SWITCH OUTLETS & JUNCTION BOXES

All outlets for switches, sockets and other receptacles shall be equipped with rust proof outlet boxes of sheet steel fabricated from minimum 16 SWG sheet and zinc

passivated as called for, having smooth external and internal surface to true finish and shall be suitable for fixing of grid mounted switches of relevant makes as called for in bill of materials. Outlets where used shall be painted with two coats of bituminous paint before they are fixed in position, outlet boxes fixed in concrete shall have a minimum depth of 65 mm and the wall thickness of the boxes and spouts shall not be less than 2 mm.

INSPECTION BOXES

Rust proof boxes of cast iron and of required size, having smooth external and internal finish, shall be provided to permit periodical inspection and to facilitate removal and replacement of wires when required. Inspection boxes shall be mounted on walls / ceiling finished surface and shall be provided with 3 /16th inch decorative laminate sheet cover to the box with brass screws. Adequate ventilation holes shall be provided.

CONDUCTORS

All PVC industrial copper conductor wires shall confirm in all respects to IS.

BUNCHING OF WIRES

Wires carrying current shall be so bunched in the conduit, that the outgoing and return cables are drawn in the same conduit. Cables originating from two different phases shall not be run in the same conduit. All wires being terminated either in switch box or else where shall be properly ferruled with circuit numbers.

DRAWING CONDUCTORS

The drawing and jointing of copper conductor wires and cables shall be executed with due regard to the following precautions:

While drawing insulated wires into the conduits, care shall be taken to avoid scratches and kinks which cause breakage of conductors. There shall be no sharp bends. Strands of wires shall not be cut for connecting terminals. The terminal shall have sufficient cross sectional area to take all strands and shall be tinned. The connecting brass screws shall have flat ends. All looped joints shall be connected through terminal blocks / connectors. The pressure applied to tighten terminal screws shall be just adequate, neither too much nor too less.

Conductors having nominal cross sectional area exceeding 4 sq. mm shall always be provided with cable sockets. At all bolted terminals, brass flat washers of large area and approved steel spring washers shall be used. Brass nuts and bolts shall be used for all connections.

Only certified wireman and cable jointers shall be employed to do jointing work. All wires and cables shall bear the manufacturer's label and shall be brought to site in new and original packaging. For all internal wiring, PVC Insulated wires 650 / 1100 V grade shall be used. The sub circuit wiring for points shall be carried out in looping system and no joint shall be made.

SWITCHES

All 6A and 16A switches shall generally be modular type switches of 230V A.C. All switches shall be fixed inside the switch boxes on the modular surface mounting plates with screws and nuts leaving ample space at the back and sides for accommodating wires. The switch controlling the light point or fan shall be connected on the phase wire of the circuit. Switches shall be located at 1200 mm above floor level unless otherwise mentioned. Switch socket outlet for UPS connections will be of a different color than that of normal switch socket outlet.

WALL SOCKET OUTLET

All 6A 3 Pin and 6 /16 A 5 Pin socket outlets shall be with switch. The sockets shall be erected approximately 1200mm above floor level unless otherwise specified on the drawings. The switch controlling the point outlets shall be on the

phase wire of the circuit. The earth terminal of the socket shall be connected to the earth terminal provided inside the box by means of copper bare wire. No joints are allowed in the length of the conductors. If the use of joint connections is unavailable due to any specific reasons, prior permission in writing shall be obtained from the Engineer before the use of such connections. No wire shall be drawn into any conduit, until all work of any nature that may cause injury to the wire, is completed. Care shall be taken in pulling the wires so that no damage occurs to the installation of the wire. Care shall be taken in pulling the wires so that no damage occurs to the installation of the wire. Before the wires are drawn in to the conduit, the conduits shall be thoroughly cleaned of moisture, dust or any other obstruction by forcing compressed air through the circuit.

Wiring for lights, exhaust fans and the wires shall be of 2.5 sq. mm. Two/Three/ Four 16A power outlets may be grouped in one circuit where called for. Wiring for the first power outlet shall be carried out with 4 sq. mm. PVC insulated copper conductor wires. Wiring for the second power outlet shall be carried out with 4 sq. mm. PVC insulated copper conductor wires. All power outlets shall be provided with PVC insulated green colour copper earth wires.

Two numbers of circuits shall be allowed in each 20mm dia conduit.

Three numbers of circuits shall be allowed in each 25mm dia conduit.

Four numbers of circuits shall be allowed in each 32mm dia conduit.

TECHNICAL SPECIFICATION FOR LIGHT FITTINGS AND ACCESSORIES

SCOPE

Supply, erection, testing, commissioning of light fittings and accessories conforming to relevant IS standards and specifications.

LIGHT FITTINGS - GENERAL REQUIREMENTS

All the light fixtures shall be of energy efficient

Fittings shall be designed for continuous trouble free operation under any atmospheric conditions without reduction in lamp life or without deterioration of materials and internal wiring. Outdoor fittings shall be weather and rain proof.

Fittings shall be so designed as to facilitate easy maintenance including cleaning, replacement of lamps / starters etc.

Outdoor type fittings shall be provided with weatherproof boxes.

Each fitting shall have a terminal block suitable for loop-out connection by 1100V PVC insulated copper conductor wires up to 4 Sq. mm. The internal wiring should be completed by the manufacturer by means of standard copper wire and terminated on the terminal block.

All hard wares used in the fitting shall be suitably plated or anodized and passivated for use in industrial atmosphere

For Earthing, each light fitting shall be provided with an earthing terminal. All metal or metal enclosed parts of housing shall be bonded and connected to the earthing terminal so as to ensure satisfactory earthing continuity throughout the fixture.

TECHNIAL SPECIFICATION FOR STREET LIGHTING

SPECIFICATION FOR STREET LIGHT POLES

The Street Light Poles shall be of steel tabular type with suitable arrangement at the top of the pole for fixing the lighting fixture. Poles shall be fabricated out of MS medium class pipes seamless type, hot dip galvanized in two or three stepped sections as per design and drawings. For reducing the section of street light poles for stepped design, "swaging" process only shall be used. Each pole would have one MS water tight box fabricated out of 16 SWG steel sheet complete with a suitable way connector, neutral link etc., as per design and drawing. The pole shall be painted with one coat of anti-corrosive oxide primer before dispatch to site and two coats of enamel/aluminium paint of approved make and shade after installation.

The earthing of each street light pole shall be carried out by connecting the Armour of the cable to the Earth Electrode, as specified in the design.

Street light poles and light fittings samples are to be got approved by client/ authorized agencies.

BRACKET FOR STREET LIGHT FITTINGS ON BUILDINGS

The brackets shall be made of specified size NB MS class 'B' pipe approx. 1.8 M long, bent at the center at an angle of 120 degree, with necessary holding brackets, hold fasts etc. with special reducer at end to accommodate type of street light fitting to be fixed. The bracket shall have one coat of anti-corrosion

paint before dispatch to site and two coats of approved make and shade of enamel paint. See attached drawing of street light poles.

INSTALLATION OF POLES

Installation of poles shall be done as per design and drawing. The depth of pole to be buried in ground shall be 1/5th of total pole length or as specified in drawing, whichever is more. Special care shall be taken in erecting poles so that these are not strained or damaged during erection and are firmly stayed till the foundation is secured.

The pole shall be grouted inside ground pit (cross section 600 x 600 mm) with cement concrete 1:2:4 with necessary GI 'A' class pipes (not less than 38 mm dia, NB) to facilitate pulling of cables. Separate pipes shall be provided for incoming and outgoing cables. The cement concrete shall be protected from premature drying by curing for at least seven days after pouring. All concrete surfaces from 150 mm below ground level to top shall be finished smooth with cement mortar 1:4.

INSTALLATION OF STREET LIGHT FIXTURES

This includes fixing of streetlight fitting complete with accessories and lamps at the end of the pole/bracket, connecting it with designed capacity and size Aluminum conductor, PVC insulated cable from water tight MS box, testing and commissioning. The third core shall be connected to earth point of marshaling MS box at the other end. If the pole has more than one light fitting, each fitting should have independent wiring from MS Box to fitting.

Fixing of street light fittings on bracket (6.10.2 above) is in Contractor's scope and also it includes the supply, fixing of necessary conduit between MS Box and fitting.

INSTALLATION OF POST TOP LANTERN FOR ENTRANCE GATE

This includes providing and fixing of specified size NB GI class 'B' pipe of 1.5M long in brick / RCC column, including MS water tight box (specification same as that of street light pole) and installation of post top lantern complete with all accessories and lamp, connecting it with designed capacity and size Aluminum conductor PVC insulated flexible cable, testing and commissioning. Painting of

the exposed portion of the pipe with two coats of approved make and shade of enamel paint is also included.

FOR OPEN GROUND

This includes providing and fixing of specified size MS class 'B' pipe of total length 4M (including 1 M in ground to be grouped with 450 x 450 x 1000 mm cement concrete 1:2:4) and water tight switch box (size 200 x 150 mm) fabricated out of 14 SWG steel sheet complete with a suitable way connector, neutral link etc., installation of post top lantern complete with all accessories and lamp connecting it with designed capacity and size Aluminum conductor, PVC insulated flexible cable, testing and commissioning. Painting of exposed pipe length with 2 coats of approved make and shade of enamel paint is also included.

CABLE BOX

Each pole should have provision for the following.
External Earthing Stud.
Suitable terminal block to connect 4 core x 10 sq. mm Cu. (loop in & loop out) cables termination. Single pole MCB with separate terminal block for lighting.

TECHNICAL SPECIFICATION FOR EARTHING

SCOPE

The section covers the requirements for providing "Earthing" connection to metal parts of equipment etc. Scope of work shall cover earthing stations, laying copper earth strips/wires and connecting the power panels, DBs and Switch Boards.

SYSTEM

Earthing systems shall comprise of earth electrodes, earth strips, earth continuity conductors and main earth grid in accordance with relevant Indian Electricity Rules IS 3034, 1987. The body earthing for panels shall be done to a common earth bus connected to two separate and distinct earth electrodes.

STANDARDS

The following standards and rules shall be applicable:

IS 3043-1987 – Code of Practice for Earthing.
Indian Electricity Rules : 1956
Indian Electricity Act : 2003
CEIG Regulations.

LOCATION OF EARTH ELECTRODE

Normally an earth electrode shall not be situated less than 1.5m from any building. Care shall be taken that the excavation for earth electrode may not affect the column footings or foundation of the buildings. In such cases electrodes may be further away from the building.

The location of the earth electrode will be such where the soil has reasonable chance of remaining moist. As far as possible, entrances, pavements and roadways, are to be definitely avoided for locating earth electrode. Before installation of earth pit it should be approved by Engineer-In-Charge.

SIZE OF EARTH LEAD

The recommended sizes of copper earth bus lead in case of substations shall be in accordance with the schedule. Copper flexible cable also shall be used as earth lead.

The minimum size of earth lead shall be of 25 x 3mm copper flat. The flats shall be buried in trench not less than 0.5 M deep.

PLATE EARTH ELECTRODE

The substation earthing shall be with copper plate earthing station unless otherwise specified. The plate earth electrode shall be made out of copper plate of 3mm thick and 600 x 600 size. The plate shall be buried vertically in ground at a depth of not less than 2.5 M to the top of the plate, the plate being encased in charcoal to a thickness of 300 mm all around. It is preferable to bury the electrode to a depth where subsoil water is present. Earth leads to the electrode

shall be laid in a heavy-duty GI pipe and connected to the plate electrode with brass bolts, nuts and washers. A GI pipe not less than 19mm dia. Shall be clamped with bolts vertically to the plate and terminated in a wire-meshed funnel. The entire arrangements shall be enclosed in a masonry chamber of 450mm X 450mm dimensions. The chamber shall be provided with GI frame and CI inspection cover. The earth station shall also be provided with a suitable permanent identifications label tag.

The earth resistance value shall be maintained with a suitable soil treatment and water arrangements as shown in the drawings. Excavated soft soil shall be thoroughly mixed with 6 percent by weight of common salt with 10 percent by weight of water and fill the eathpit. The earth lead shall be connected to the earth plate through copper / brass bolts.

PIPE EARTH ELECTRODE

The earth electrode shall be of dual pipe with flat technology with strong long terminal flat inside. Both the outer shell and inner shell of the pipe shall be of 3.25 mm thick in a standard length of 3 mtrs. The hot dip galvanization shall be to a maximum of 80 -100 microns outside and more than 300 – 400 microns inside. The special conducting compound consisting of different naturals & minerals shall be filled inside the earth pit.

Earth cable leads to the electrode shall be laid in a heavy-duty GI pipe and connected to the electrode with brass bolts, nuts and washers. The entire arrangements shall be enclosed in a masonry chamber of 450mm X 450mm dimensions.

The earth station shall also be provided with a suitable permanent identifications label tag. The earth station indication number shall clearly write in the inner side of the cover. The chamber shall be provided with GI frame and CI inspection cover. Cast iron cover having locking arrangement shall be suitably embedded in the masonry enclosure.

METHOD OF INSTALLATION OF WATERING ARRANGEMENT

In the case of plate earth electrode a watering pipe of 25/32 mm dia medium class G.I. pipe shall be provided and attached to the electrode. A funnel with mesh shall be provided on the top for watering the pit.

PROTECTION OF EARTHING LEAD

The earthing lead from electrode onwards shall be suitably protected from mechanical injury by a 20 mm / 25 mm dia medium class G.I. pipe. Portion of this protection pipe within the ground shall be buries at least 300 mm deep to be increased to 600mm incase of road crossing and pavements. The portion with in the building shall be recessed in walls and floor to adequate depth.

JOINTING

Earthing connections with equipment earthing pads shall be bolted type. Contact surface shall be free from scale, paint enamel, grease, rust or dirt. Two bolts shall be provided for making each connection. Bolted connection shall be taped with PVC tape after being tested. Resistance of the joint shall not be more than the resistance of the equivalent length of the conductor.

TESTING DURING ERECTION AND COMMISSIONING

On the completion of entire installation the following inspection and test shall be conducted.

- Earth pit and visual inspection for joints with adequate size nuts and bolts.
- Inspection of funnel and clean water passage for any obstruction.
- Openable covers of masonry chamber.
- Earth testing point.
- Check earth pit resistance individually and combined.
- Impedance of earth continuity conductors as per IS 3043.
- Effectiveness of earthing as per IS 3043.
- Each earth pit shall carry separate number.
- Initially if earth resistance is high due to hard soil / rock than big hole must be excavated and filled with soft soil before carrying out conventional system of salt and charcoal.
- Resistance of earthing system shall not exceed one ohm.
- All the above earth test results to be recorded in the standard format to be given

Alternative Advanced Earthing Systems

SPECIFICATION FOR TRIPOD EARTHING SPECIFICATION

Supply of standard earth pit comprising of 3 Nos of Copper bonded electrodes per pit less than 12mm dia and 3 M length should keep in Tripod mode 1m apart with each other and shorted with 25 x 3 mm stripe and it has to be non corrosive and longer life with Process to be used earthing with RESLO-10 (Resistance Lowering Compound)

Characteristics of Good Grounding System:

- ✓ Good Electrical conductivity in function.
- ✓ Good Corrosion Resistance.
- ✓ Mechanically robust and reliable.

Maintenance-free TRIPOD Earthing System consists the below mentioned products:

1. Copper bonded Earth Rods:

Copper bonded Earth Rod at a depth of minimum 3 metres and it should be High corrosion resistance using 99.98% pure electrolytic copper of up to 0.35mm thick. Copper Bonded rods . These Coppers bonded rods are provided with a Nickel bonding interface to avoid galvanic corrosion.

Copper bonded Steel Earth Rods are commonly utilized as the principle earth electrode in the design and installation of an earthing system.

Our offers a selection of copper bonded steel solid copper and stainless steel earth rods which are manufactured to meet international standards. The copper bonded steel rod is the most commonly used type of earth rod due to its overall combination of strength, corrosion resistance, low resistance path to earth and cost effectiveness.

2. **Resistance Lowering Compound (RESLO):**

The requirement of a good earth resistance is extremely important with the installation of any earthing system.

RESLO (Resistance Lowering Compound) provides the ability to dramatically reduce soil resistivity even in soils with average electrical conductivity.

RESLO is comprised of specifically selected compounds, which possess excellent electrical conductivity. WHEN RESLO is mixed with water and poured on the earthing system and surrounding soil the powder and water react to form a

hardened mass within your earthing system. RESLO will not wash away under seasonal conditions and therefore provides a permanent presence in working to improve and maintain the integrity of your earthing system. Given that RESLO does not wash away the requirement to re-treat the soil as in the case with other enhancing compounds is eliminated.

RESLO is supplied in multiples of 10KG-packaged bags to suit your site application. These packaged bags have full installation and handling instructions and combine a plastic handle and HDPE plastic inner for easy and safety of handling.earth rod and conductor for disconnect and maintenance.

TECHNICAL SPECIFICATION FOR INSTALLATION

SCOPE

The specification covers the installation, testing and commissioning of all electrical equipment's and accessories required for the installation and trouble free operation.

STANDARDS

The electrical installation work covered by this specification shall unless otherwise stated comply with the requirements of the latest edition of relevant Indian Standard, statutory regulations and codes of practices.

- Indian Electricity Rules –1956
- IS – 10118 : Code of practice for selection, installation & maintenance of switch gear and control gear
- IS – 3043 : Code of practice for earthing.
- IS – 2309 : Code of practice for protection of building and allied structures against lightning.
- IS – 6665 : Code of practice for industrial lightning.
- IS – 732 : Code of practice for Electrical wiring installation
- IS – 1646 : Code of practice for Fire safety of Buildings
- IS – 8623 : Specification for Factory built assemblies for voltages upto 1.1KV A.C. & 1.2KV D.C.

GENERAL REQUIREMENTS

An electrical contractor holding a valid license as required by the respective State Government shall carry out the installation. The contractor shall provide particulars of the license held by him or his subcontractor to the purchaser. The installation shall require approval of the Chief Electrical Inspector to the Government of Tamil Nadu and the contractor shall prepare all necessary drawings / documents and submit to CEIG and get safety certificates from CEIG. He shall also fully assist the purchaser in obtaining approval from any other statutory authorities for the successful commissioning of the Substation. Getting approval for other areas like 11KV switch gear, Transformer, control and relay panels and LT panels shall also be in the contractor's scope for which the necessary details shall be arranged by Client / Consultant.

Any modification in the equipment or installation that may be demanded by the inspector shall be carried out at no additional cost to the purchaser.

In accordance with the specific installation instructions or as directed by the purchaser, the contractor shall unload, erect, assemble, install, wire, test and commission all electrical equipment's included in this contract. Equipment's shall be installed in a neat workman like manner with highest regard for safety.

The purchaser shall not supply erection materials, tools, testing instruments or any other machinery of any nature. The contractor shall arrange for the same in a timely manner and he shall not be allowed to claim for any delay or extra cost of any nature.

Consumable materials of any nature required for the erection job shall also have to be arranged by the contractor.

Clearing the site after completion of erection as well as regular clearance of unwanted, materials from site, returning all packing material and excess material and excess material shall also be covered under the scope of work.

All equipment's and instruments of indoor and outdoor, shall be inscribed with number, nomenclature, danger boards and other instructions.

The contractor shall touch up the surface for all equipment's, which are scratched and / or damaged during transportation and erection. The paint used shall match exactly the surface being touched up.

The contractor shall employ skilled laborers for erection, installation & testing as required. All electricians, cable jointers, wire men, welders and others employed shall be suitably qualified possessing valid certificates / licenses recognized by the competent authorities

The contractor shall also furnish a list of Engineers/Supervisors and staff employed by him for erection and installation jobs, giving in brief, qualification and experience of such staff and indicating whether they hold such competency certificates / licenses to supervise the electrical installation jobs as required under Indian Electricity Rules & State electrical Inspectorate Rules.

The contractor shall set up his own workshop and other facilities at site to undertake fabrication jobs, pipe bending, threading etc.

The contractor shall be responsible for recording of all readings and observations during erection, testing and commissioning, in registers or on prescribed proforma. These shall be carried in the presence of purchaser's representative. The contractor's Engineer shall duly sign all such test data and records together with the Client's representative and shall be submitted to the Client in triplicate.

The contractor shall carry out all tests at site for outdoor and indoor electrical equipment and commission the installation in the presence of Client's representative. The contractor shall be responsible for final adjustment of relays, instruments, meters breakers etc., and also for submission of relay settings and calculations.

TRANSFORMERS

The distribution transformers shall be tested and installed in accordance with the manufacturer's drawings and instructions.

The level of rails on foundations shall be checked before erection and necessary stoppers shall be provided at the wheels after erection.

HT PANEL BOARDS

The HT Panel board shall be tested and installed in accordance with the manufacturer's drawings and instruction.

The operating mechanism shall be installed and connected to the three poles and the control cubicle.

Each pole of the circuit breaker and operating mechanism shall be accurately positioned not to cause any undue strain on the terminals and they shall be properly earthed. Inter panel

Wiring shall be done after erecting the panels. Fixing bolts and bus bar bolts shall be tightened using a torque wrench.

BUSDUCT

The Busduct shall be assembled, tested and installed in accordance with the manufacturer's drawing and instruction. It shall be supported from the ceiling / wall with necessary supporting arrangements required as per the site conditions.

It should be ensured that all the ends and joints of the busbars are properly tightened using a torque wrench.

The wall openings of the Busduct entry shall be sealed with fire retardant materials.

Contractor shall install, test and commission the Busduct specified in accordance with the latest revisions of Indian Standards.

LV PANEL BOARDS

The contractor shall inspect, clean, assemble, align and install the panel boards on the fabricated base structure.

Inter panel wiring shall be done after erecting the panels. Fixing bolts and bus bar bolts shall be tightened using a torque wrench.

The unused cable entry holes shall be covered after completion of cable laying and termination work.

POWER CABLES

The scope of work includes unloading, laying, fixing, jointing, bending and terminating of cables. Contractor shall also supply all the necessary hardware's for jointing and terminating of cables. Cable shall be laid directly buried in earth, on cable racks in built up trenches, on cable trays and supports in conduits and ducts or bare on walls, ceiling etc. Where specific cable layouts are not shown in the drawing contractor shall route these cables as directed by Engineer.

Markers shall be installed at all road crossing and joint positions. Their provision and installation shall be included in the areas.

Contractor shall install, test and commission the cables specified in accordance with the latest revisions of Indian Standards.

All cable work and the allied apparatus shall be designed and arranged to reduce the risk of fire and any damage that may cause in the event of fire. Wherever cables pass through any floor or wall opening suitable bushes supplied shall be sealed using fire-resisting materials to prevent fire spreading.

Standard cable installation tools shall be utilized for cable pulling. Maximum pull tension shall not exceed the manufacturer's recommended value. Cable grips, reels or pulleys used shall be properly lubricated. The lubricant shall not injure the overall covering and shall not set up undesirable conditions of electrostatic stress.

Sharp bending and kicking of cables shall be avoided. The bending radius for various types of cables shall not be less than those specified by manufacturer.

Power and control cables shall be laid in separate cable trays. The order of laying of various cable in trenches shall be as shown on the drawings.

Where cables cross roads (Provisions will be made by others for road crossing) and water, oil, gas or sewage pipes the cables shall be laid in reinforced spun concrete pipes. For road crossing the pipe for the cable shall be buried at not less than one-meter depth. Cable shall be protected at all times from mechanical damage and from absorption of moisture.

Some extra length shall be kept in each cable run at a suitable point to enable one or two straight through joint to be made at a later date, if any fault occurs.

Cable jointing shall be in accordance with relevant Indian Standard Codes of practice and Manufacture's special instruction. Contractor should supply materials and tools required for cable jointing work. Cable shall be firmly clamped on either sides of a straight through joint at not more than 300 mm away from the joints.

Identification tags shall be provided at each joint and at all cable terminations. Before jointing insulation resistance of both sections of cables to be jointed shall be checked.

Metal sheath and armour of the cable shall be bonded to the earthing system of the station.

Cable clamps shall be of 3 mm thick galvanized Al. spaced at every 0.5-M interval.

CABLE LAYING AND HANDLING

It should be ensured that both ends of the cable are properly sealed to prevent ingress / absorption of moisture by the insulation.

When cable drums have to be moved over short distances, they should be rolled in the direction of the arrow, marked on the drum.

While removing cables the drums shall be properly mounted on jacks or on a cable wheel or any other suitable means marking sure the spindle, jack etc., is strong enough to take the weight of the drum.

The cables shall not be bent sharp to a small radius. The minimum safe bending radius for all types of PVC cable shall be taken as 12 times the overall diameter of the cable. Normally, No joints in cable will be allowed.

Wherever practicable, larger radius should be adopted. At joints and terminations, the bending radius of individual cores of a multi core cable shall not be less than 15 times its overall diameter.

Cable of different voltages and also power and control cables if kept in same trenches shall be provided with adequate separation.

Where cables cross one another the cable of higher voltages shall be laid at a lower level than the cable of lower voltage.

Power and communication cables shall be as far as possible cross at right angles. Where power cables are laid in proximity with communication cables the horizontal and vertical clearances shall not normally be less than 200mm.No joints in cable shall be allowed. Only in cases where the joint cannot be avoided during the preliminary stages of laying the cable and this should be brought to the notice of the site engineer for proper approval.

The PVC cables shall not in any circumstances be bent so as to form an abrupt right angle but must be rounded off at the corners to a radius not less than six times the overall diameter of the cable.

While cutting and stripping of the outer covering of the cable, care shall be taken that the sharp edge of the cutting instrument does not touch the inner insulation of the conductors. The

protective outer covering of the cables shall be striped off near connecting terminal as far as practicable.

Care shall be taken to avoid hammering on link clips with any metal instrument, after the cables are laid. When junction boxes are provided, they shall be made moisture proof with a plastic compound.

All cabling shall have a tags at both ends with proper circuit number, details of load, machine etc marked on it.

Each cable shall be identified with its designation number as indicated in the drawings.

CABLE LAID IN CABLE TRAYS

Cable trays shall either be run in concrete trenches or overhead supports from building steel, floor slab, etc.

Suitable prefabricated clamps shall clamp Cables to the cable trays in both horizontal runs and vertical runs.

All cable trays / Ladder and fitting will be fabricated from M.S. sheet and shall be hot dip galvanized.

Cable trays shall be suitably supported at an interval of not more than 1.5 meter.

SUPPORT FOR CABLE TRAYS:

Supports shall be Flexible system consisting of Slotted Verticals / MS Painted / MS Galvanized wherever called for.

The system should be fixable to walls, columns, ceilings, and floors and also from floor to ceiling. Wall clamps, footplates, ceiling plates and telescopic coupler channels etc., which are required for fixing as above should be available as standard equipment.

All sections like stand, racks, and clamps shall be of minimum 2.5mm thickness (12 SWG). All mounting shall be of 3.5mm to 6mm thickness.

All products for the support system shall be Hot Dip Galvanized as per IS: 2629 to achieve uniform zinc coating not less than 60 microns at any spot.

CABLE – OUTDOOR TRENCHES

Cables shall be laid in outdoor trenches wherever called for. The width of the trenches shall not be less than 450 mm. However, where more than one cable is

laid, a coaxial distance of not less than 150 mm shall be allowed between the cables. The trenches shall be cut square with vertical sidewalls and with uniform depth. Suitable shoring and propping may be done to avoid caving-in of trench walls. The floor of the trench shall be rammed level. The cables shall be laid in trenches over rollers placed inside the trench.

Wherever cables are bent, the minimum-bending radius shall not be less than 12 times the diameter of the cable. After the cable is laid and straightened, it shall be covered with 80 mm / 50 mm thick layer of sand. The cable shall then be lifted and placed over the sand cushion. Over this, 300 mm thick layer of sand shall be covered and a course of cable protection tiles or RCC troughs shall be provided to cover the cables by 50 mm on either side. Remaining trench shall be backfilled with earth and consolidated as original.

Cables shall be laid in hume Pipes / stoneware pipes at all road crossings and in GI pipe at the wall entries. Cable route markers are to be provided as per standards. Excess debris shall be removed from site free of cost by the contractor.

CABLES - INDOOR

The cables laid indoors should be laid on GI cable trays supported on M.S. angles / slotted angle supports. The cable trays should be routed above false ceilings wherever required.

Suitable clamping with straps and saddles shall be used for keeping the cables in position.
The derating of the cable is based on the number of cables bunched together.

The cables on wall surface from panel board up to angle iron shall run in galvanized steel pipes of adequate size or Cable Tray / Duct as required.

The Cables run inside concrete trenches shall be supported on cable trays and shall be neatly arranged and clamped.

The Cable entries through pipes from outside to inside the building shall be sealed water tight with approved type of sealant to avoid water entering the building.

TESTING DURING ERECTION AND COMMISSIONING

- Continuity test prior to laying cables.
- Physical and visual check for any apparent damage cuts and armour piercing.

- Insulation resistance test prior to cable laying.
- Insulation resistance test after cable laying.
- Megger test before and after installation.

POWER AND CONTROL CABLE TERMINATIONS

Cable boxes shall be of approved design with adequate clearances between phases and between phases and earth, in accordance with relevant standards.

Cable boxes shall be complete with combined armour and earthing clamps.

Suitable compression type cable glands shall be provided for power and control cables.
Provision shall be made for earthing the body of each cable box.

Equipment terminal blocks for power connections shall be complete with adequate phase segregating insulating barriers and suitable crimping type of lugs for connecting the insulated cable tails. Where more than one core is terminated on each phase, unnecessary bending of cable cores shall be avoided, without decreasing the length of the insulated cable tail and the electrical clearances, which would normally be obtained when using one core per phase.

The individual cores of power and control cables shall be neatly dressed and supported at regular intervals inside the switchboards, before connecting them to the relevant terminals.

EARTHING

The size of the earth bus and earth electrode shall be as per specification and as per schedule. All joints shall be riveted and sweated. Joints in the earth bar shall be bolted and the joint faces tinned. Where the diameter of the bolt for connecting earth bar to apparatus exceeds one quarter of the width of the earth bar, the connection to the bolt shall be made with a wider

piece of flange of copper jointed to earth bar. These shall be tinned at the point of connection and special care taken to ensure a permanent low resistance contact to iron or steel.

All steel bolts, nuts, washers, etc shall be cadmium plated. Main earth bars shall be spaced sufficiently away from the surface to which they are fixed, such as walls or the side of trenches to allow for easy connections. The earthing shall be

suitably protected from mechanical injury by galvanized iron with in ground shall be buried at least 600 mm deep.

The earthing lead shall be securely bolted and soldered to the plate or pipe as the case may be. In the case of the plate, the lead shall be connected by means of cable socket with two bolt and nuts. All iron bolts, nuts and washers shall be galvanized.

TESTING DURING ERECTION AND COMMISSIONING

- Completion of earth pit and visual inspection for joints with adequate size nuts and bolts.
- Inspection of funnel and clean water passage for any obstruction.
- Openable covers of masonry chamber.
- Earth testing point.
- Check earthing pit resistance individually and combined.
- Each earthing pit shall carry separate number.
- Initially if earth resistance is high due to hard soil / rock than big hole must be excavated and filled with soft soil before carrying out conventional system of salt and charcoal.
- Resistance of earthing system shall not exceed one ohm.
- All the above earth test results to be recorded in the standard format to be given

INSPECTION

After completion of erection / installation of all the equipments, each piece of equipment shall be thoroughly inspected in the presence of the contractor to ensure that the completion of erection work.

MISCELLANEOUS ITEMS

The successful bidder shall supply and install the safety devices as required by the statutory authorities, but not limited to the following:

- Danger boards.
- Fire extinguishing appliances.
- Rubber mats for switchgear panels, power distribution boards battery charges, control and relay panel, etc.
- Rubber gloves, first aid charts, first aid box and Earthing rods.

TECHNICAL SPECIFICATION FOR TESTING AND COMMISSIONING

GENERAL

The testing and commissioning for all electrical equipment at site shall be according to the procedure given below.

All electrical equipment shall be installed, tested and commissioned in accordance with the latest relevant standards and codes of practices published by Indian standards, institution wherever applicable and stipulations made in relevant general specifications.

The testing of all electrical equipment as well as the system as a whole shall be carried out to ensure that the equipment and its components are in satisfactory condition and will successfully perform its functional operation. The inspection of the equipment shall be carried out to ensure that all materials, workmanship and installation conform to the accepted design, engineering and construction standards, as well as accepted codes of practice and stipulations made in the relevant general specifications.

The contractor using his own instruments, testing equipment as well as qualified testing personnel shall carry out all tests.

The results of all tests shall be conforming to the specification requirements as well as any specific performance data guaranteed during finalization of the contract.

At the completion of the work, the entire installation shall be subject to the following tests in presence of Client/Consultant.

- Wiring Continuity Test
- Insulation Resistance Test
- Earth Continuity Test
- Earth Resistivity Test

PREPARATION OF THE ELECTRICAL SYSTEM FOR COMMISSIONING

After completion of the installation at site and for the preparation of Electrical system commissioning, the contractor shall carry out check and testing of all equipment and installation in accordance with the agreed standards, codes of practice of Indian Standards Institution and specific instructions furnished by the particular equipment suppliers.

Checking required to be made on all equipment and installations at site shall comprise, but not be limited, to the following:

The following checks shall be made on all equipment and installation at site:

- Physical inspection for removal of any foreign bodies, external defects, such as damaged insulators, loose connecting bolts, loose foundation bolts etc.
- Complete cleaning of all switchboards, inside & outside
- Check for grease, insulating/lubricating oil leakage and its proper quantity.
- Check for the free movement of mechanism for the circuit breakers, rotating part of the rotating machines and devices.

- Check for tightness of all - cable, bus bars at termination/joints ends as well as earth connections in the main earthing network.
- Check for Clearance of live bus bars and connectors from the metal enclosure.
- Check the proper alignment of all draw out device like draw out type circuit breakers.
- Continuity checks in case of power cables.
- Checking of all mechanical and electrical interlocks including tripping of breakers using
  manual operation of relay.

- Checking of alarm and annunciation circuits by manual actuation of relevant relays.
- Check and calibrate devices requiring field adjustment/ calibration like adjustment of relay settings etc.,
- Check proper connection to earth network of all non-current carrying parts of the equipment and installation.

H.T. BREAKER PANEL

The following tests shall be carried out in accordance with IS 13118.

- Mechanical operation tests.
- Insulation resistance test.
- Functional tests on control circuits.
- Relay operation tests by primary, secondary injection method.
- Checking of settings of all relays/releases as per single line diagram/specification.

TRANSFORMER

The following tests shall be carried out in accordance with IS

MEASUREMENT OF INSULATION RESISTANCE TEST BETWEEN:-

- HT & LT Windings
- Between HT & Earth
- Between LT & Earth

EARTH RESISTANCE TEST

- Earth resistance of the Body earth Electrodes
- Earth resistance of the Neutral earth Electrodes
- Earth continuity

VOLTAGE RATIO TEST

Ratio test on all taps of the transformers

OTHERS

- Testing of Control Circuits in Marshaling box for various trip.
- Winding resistance at all taps.
- Measurement of voltage ratio on all taps.
- Vector group check.
- Measurement of impedance voltage / Short Circuit impedance
- At principal tapping and load loss.
- Measurement of no load loss and current.
- Measurement of insulation resistance.
- Power frequency withstand test
- Operational tests to know the correct functional of all devices associated with the transformer.

LOW VOLTAGE SWITCH GEAR (up to 1000V AC OR 1200V DC)

- Insulation resistance test with 1000V megger for main circuits. The minimum value of insulation resistance shall be 1 Meg ohm.
- Insulation resistance test with 500V megger for control, metering and relaying circuits. The minimum value of insulation resistance shall be 1 Meg ohm.
- Relay operation test by primary & Secondary injection method.
- Functional tests of control circuit.
- Checking of settings of all relay/releases as per single line diagram/specification.
- ON/OF operation of breakers both manually and electrically in "Test" as well as "service" positions.

CABLES

- Insulation resistance test with 2,500V megger for high voltage power cables rated above 1.1KV grade and 1,000V megger for cables rated up to 1.1KV grade.

- All cables of 1.1KV and M.V. cables shall be subjected to high voltage test after joining and terminating but before commissioning as per relevant standards.

- In each test, the metallic sheath/screen/armour should be connected to earth.

- Continuity of all the cores, correctness of all connections as per wiring diagram, correctness of polarity and phase of power cables and proper earth connection of cable glands, cable boxes, armour and metallic sheath shall be checked.

EARTHING SYSTEM

- Tests to ensure continuity of all earth connections.

- Tests to obtain earth resistance of the complete network by using earth tester. The test values obtained shall be within the limits.

ELECTRICAL

The scope of work for testing and commissioning of the total installation shall be for the capital equipment's like switchgears, cables, etc., and also for the associated equipment like relays CTs, PTs cable etc.,

The scope of work for testing and commissioning of electrical equipment for the above shall be included the following.

- Providing sufficient number of experienced Engineers, supervisors, Electricians, so that the installation can be commissioned in stipulated time.

- All the instruments, tools, and tackles required for carrying out the testing and the bidder shall provide commissioning.

- The testing of electrical equipments shall be carried but as per the relevant Indian standards/codes practices/Manufacturers instructions.

- Cleaning of Electrical equipment, contracts, cleaning and greasing etc., all the equipment and material required for above shall be supplied by the bidder.

- Correcting the panel/equipment wiring for proper functioning for the schemes required /called etc.,

- Installation and wiring of additional equipment on panels like auxiliary contractors, timers, etc., which may be additionally required for proper functioning of the schemes.

- Checking of equipment earthing and system earthing as a whole.

- Testing of all the cables.

- Co ordination with other contractors for testing and commissioning of interface cables.

TEST TO BE CONDUCTED

All tests shall be performed in the presence of the bidder and customer/consultant.

For all types of visual inspections, checkings, precommissioning, commissioning test and acceptance tests, relevant IS for the tests given therein shall be followed in addition to the instructions in this technical specification the intention of giving the few test procedures, described below, is to provide a guideline for the bidder.

However bidder shall not restrict them in carrying out only the tests described in this document.

Bidder shall submit their proposed test procedures for approval and shall not commence testing without such approval is given.

Bidder shall check and test all electrical equipment and system installed and supplied them, including equipment supplied by the client.

Bidder shall ensure that no tests are applied which may stress equipment above the limits for field-testing recommended by the manufacturer. Bidder shall be responsible for any damage to personnel or equipment resulting from improper test procedure including the equipments supplied by Client.

All defective materials furnished by the bidder and defects due to poor workmanship revealed through field testing, shall be corrected at bidder expense without affecting the completion of the project at no extra cost.

CLIENT reserves the right to interpret and approve all test results prior to energisation of circuits or apparatus.

Bidder shall visually inspect all equipment for defects immediately results upon arrival at site including those supplied by Client.

Auxiliary wiring rated less than 415 volts shall be tested with a 500 volts megger.

All protective relays shall be tested at sufficient points to establish their proper functioning in accordance with manufacturer's specification and curves.

Operation checks and functional checks on all switchgear panels.

Busbar Wires and cables rated 433 volts or more shall be tested joints check with torque wrench for tightness.

Resistance of all wires and cables shall be tested with a 1000 volts megger. Cables rated less than 433 volts shall be tested with a 500 volts megger.

No wires or cable having resistance between conductors or between conductors and ground if less than 100 megohm shall be accepted.

All precommissioning test stated as per IS for respective items.