Additional Appendix B

Specifications for Works

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SPECIFICATIONS FOR CIVIL WORKS

1. Earth Work

2. LIST OF BUREAU OF INDIAN STANDARD CODES

S. No.	*I.S. No.*	*Subject*
1	IS 632	Gamma – BHC (Lindane) emulsifiable concentrates
2	IS 1200 (Pt 1)	Method of measurement of earth work
3	IS 1200 (Pt-27)	Method of measurement of earth work (by Mechanical Appliances)
4	IS 4081	Safety code for Blasting and related drilling operation
5	IS 4988 (Part IV)	Excavators
6	IS 6313 (pt-II)	Anti Termite measures in buildings (pre -constructional)
7	IS 6313(pt.-III)	Anti Termite Measures in Buildings for existing buildings
8	IS 6940	Methods of test for pesticides and their formulations
9	IS 8944	Chlorpyrifos emulsifiable concentrates
10	IS 8963	Chlorpyrifos – Technical specifications
11	IS 12138	Earth moving Equipments

DEFINITIONS

Foul condition: Filthy and unhygienic conditions where physical movements are hampered such as soil mixed with sewage or night soil.

Lead: All distances shall be measured over the shortest practical route and not necessarily the route actually taken. Route other than shortest practical route may be considered in cases of unavoidable circumstances and approved by Engineer-in-charge/Consultant/ along with reasons in writing.

Carriage by animal and mechanical transport shall be reckoned in one km. unit. Distances of 3 km.

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

Safety rules: Safety rules as laid down by the statutory authority and *as provided in National Building Code (NBC) shall be followed.*

2. CLASSIFICATION OF SOILS

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

(a) ***All kind of soils:*** Generally any strata, such as sand, gravel, loam, clay, mud, black cotton moorum, shingle, river or nallah bed boulders, siding of roads, paths etc. and hard core, macadam surface of any description (water bound, grouted tarmac etc.), lime concrete mud concrete and their mixtures which for excavation yields to application of picks, showels, jumper, sacrifiers, ripper and other manual digging implements.

2.2 ANTIQUITIES AND USEFUL MATERIALS

2.2.1 Any finds of archaeological interest such as relics of antiquity, coins, fossils or other articles of value shall be delivered to the Engineer-in-charge/ /Consultant and shall be the property of the Government**.**

2.2.2 Any material obtained from the excavation which in the opinion of the Engineer-in-charge/ /Consultant is useful shall be stacked separately in regular stacks as directed by the Engineer-in-charge/ /Consultant and shall be the property of the Government.

2.3 PROTEC TIONS

2.3.1 Excavation where directed by the Engineer-in-charge/ /Consultant shall be securely barricaded and provided with proper caution signs, conspicuously displayed during the day and properly illuminated with red lights *and/or written using fluorescent reflective paint as directed by engineer in charge* during the night to avoid accident.

2.3.2 The Contractor shall take adequate protective measures to see that the excavation operations do not damage the adjoining structures or dislocate the services. Water supply pipes, sluice valve chambers, sewerage pipes, manholes, drainage pipes and chambers, communication cables, power supply cables etc. met within the course of excavation shall be properly supported and adequately protected, so that these services remain functional. However, if any service is damaged during excavation shall be restored in reasonable time.

2.3.3 Excavation shall not be carried out below the foundation .

2.3.4 Any damages done by the contractor to any existing work shall be made good by him at his own cost. Existing drains pipes, culverts, overhe ad wires, water supply lines and similar services encountered during the course of execution shall be protected against damage by the contractor. The contractor shall not store material or otherwise occupy any part of the site in manner likely to hinder the operations of such services.

2.4 SITE CLEARANCE

2.4.1 Before the earth work is started, the area coming under cutting and filling shall be cleared of shrubs, rank vegetation, grass, brushwood, trees and saplings of girth up to 30cm measured at a height of one metre above ground level and rubbish removed up to a distance of 50 metres outside the periphery of the area under clearance. The roots of trees and saplings shall be removed to a depth of 60cm below ground level or 30 cm below formation level or 15 cm below sub grade level, whichever is lower, and the holes or hollows filled up with the earth, rammed and leveled.

2.4.2 Lead of 3km m mentioned in the 'Schedule Of Quantities' is the average lead for the disposal of excavated earth within the site of work. The actual lead for the lead for the disposal of earth may be more or less than the 3km m for which no cost adjustment shall be made in the rates.

2.4.3 Disposal of Earth shall be disposed off at the specified location or as decided by the Engineer-in-Charge. The contractor has to take written permission about place of disposal of earth before the earth is disposed off, from Engineer-in-charge/Consultant/.

2.5 SETTING OUT AND MAKING PROFILES

2.5.1 A masonry pillar to serve as a bench mark will be erected at a suitable point in the area, which is visible from the largest area. This bench mark as approved by the Engineer-in-charge/ /Consultant.

Necessary profiles with strings stretched on pegs, bamboos or 'Burjis' shall be made to indicate the correct formation levels before the work is started. The contractor shall supply labour and material for constructing bench mark, setting out and making profiles and connecting bench mark with the standard bench mark at his own cost. The pegs, bamboos or 'Burjis' and the bench mark shall be maintained by the contractor at his own cost during the excavation to check the profiles.

2.5.2 The ground levels shall be taken at 5 to 15 metres intervals as directed by the Engineer-in-Charge.

2.6 EXCAVATION IN ALL KINDS OF SOILS

2.6.1 All excavation operations manually or by mechanical means shall include excavation and 'getting out' the excavated materials. In case of excavation for trenches, basements, water tanks etc. 'getting out' shall include throwing the excavated materials at a distance of at least one metre or half the depth of excavation, whichever is more, clear off the edge of excavation. In all other cases 'getting out' shall include depositing the excavated materials as specified. The subsequent disposal of the excavated material shall be either stated as a separate item or included with the items of excavation stating lead.

2.6.2 During the excavation the natural drainage of the area shall be maintained. Excavation shall be done from top to bottom. Undermining or undercutting shall not be done.

2.6.3 In firm soils, the sides of the trenches shall be kept vertical upto a depth of 2 metres from the bottom. For greater depths, the excavation profiles shall be widened by allowing steps of 50 cms on either side after every 2 metres from the bottom. Alternatively, the excavation can be done so as to give slope of 1:4 (1 horizontal : 4 vertical). Where the soil is soft, loose or slushy, the width of steps shall be suitably increased or sides sloped or the soil shored up as directed by the Engineer-in- Charge. It shall be the responsibility of the contractor to take complete instructions in writing from the Engineer-in-charge/ /Consultant regarding the stepping , sloping or shoring to be done for excavation deeper than 2 metres.

2.6.4 The excavation shall be done true to levels, slope, shape and pattern indicated by the Engineer-in-Charge. Only the excavation shown on the drawings with additional allowances for centering and shuttering or as required by the Engineer-in-charge/ /Consultant shall be measured and recorded for payment.

2.6.5 In case of excavation for foundation in trenches or over areas, the bed of excavation shall be to the correct level or slope and consolidated by watering and ramming. If the excavation for foundation is done to a depth greater than that shown in the drawings or as required by the Engineer-in-charge/ /Consultant, the excess depth shall be made good by the contractor at his own cost with the concrete of the mix used for levelling/ bed concrete for foundations. Soft/defective spots at the bed of the foundations shall be dug out and filled with concrete (to be paid separately) as directed by the Engineer-in-charge/ /Consultant.

2.6.6 While carrying out the excavation for drain work care shall be taken to cut the side and bottom to the required shape, slope and gradient. The surface shall then be properly dressed. If the excavation is done to a depth greater than that shown on the drawing or as required by the Engineer-in-charge/ /Consultant, the excess depth shall be made good by the contractor at his own cost with stiff clay puddle at places where the drains are required to be pitched and with ordinary earth, properly watered and rammed, where the drains are not required to be pitched. In case the drain is required is to be pitched, the back filling with clay puddle, if required, shall be done simultaneously as the pitching work proceeds. The brick pitched storm water drains should be avoided as far as possible in filled-up areas and loose soils.

2.6.7 In all other cases where the excavation is taken deeper by the contractor, it shall be brought to the required level by the contractor at his own cost by filling in with earth duly watered, consolidated and

rammed.

2.6.8 In case the excavation is done wider than that shown on the drawings or as required by the Engineer-in-charge/ /Consultant, additional filling wherever required on the account shall be done by the contractor at his own cost.

2.6.9 The excavation shall be done manually or by mechanical means as directed by Engineer-in-charge/ /Consultant considering feasibility, urgency of work, availability of labour /mechanical equipments and other factors involved. Contractor shall ensure every safety measures for the workers. Neither any deduction will be made nor any extra payment will be made on this account.

2.7 EARTH WORK BY MECHANICAL MEANS

Earth work by mechanical means involves careful planning keeping in view site conditions i.e. type of soil, nature of excavation, distances through which excavated soil is to be transported and working space available for employing these machines. The earth moving equipment should be accordingly selected.

The earth mechanical means moving equipment consists of excavating and transporting equipment

2.8 FILLING

2.8.1 The earth used for filling shall be free from all roots, grass, shrubs, rank vegetation, brushwood, tress, sapling and rubbish.

2.8.2 Filling with excavated earth shall be done in regular horizontal layers each not exceeding 20 cm in depth. All lumps and clods exceeding 8 cm in any direction shall be broken. Each layer shall be watered and consolidated with steel rammer or ½ tonne roller. Where specified, every third and top must layer shall also be consolidated with power roller of minimum 8 tonnes. Wherever depth of filling exceeds 1.5 metre vibratory power roller shall be used to consolidate the filing unless otherwise directed by Engineer-in-charge/ /Consultant. The top and sides of filling shall be neatly dressed. The contractor shall make good all subsidence and shrinkage in earth fillings, embankments, traverses etc. during execution and till the completion of work unless otherwise specified.

2.8 MEASUREMENTS

2.8.1 The length and breadth of excavation or filling shall be measured with a steel tape correct to the nearest cm. The depth of cutting or height of filling shall be measured, correct to 5 mm, by recording levels before the start of the work and after the completion of the work. The cubical contents shall be worked out to the nearest two places of decimal in cubic metres.

2.8.1.1 In open footing depth of more than 1.5 metre Only as per drawing PCC area shall be measured for payment. Noting extra paid for the centering and shuttering allowance. Additional excavation beyond this limit shall be at the risk and cost of the contractor and shall not be measured for payment.

2.8.1.2 In case of open footings/Rafts of more than 1.5 metre Only as per drawing PCC area shall be measured for payment. Noting extra paid for the centering and shuttering allowance. Additional excavation beyond this limit shall be at the risk and cost of the contractor and shall not be measured for payment.

2.8.3 In case the ground is fairly uniform and where the site is not required to be levelled, the Engineer-in-charge/ /Consultant may permit the measurements of depth of cutting or height of filling with steel tape, correct to the nearest cm. In case of borrow pits, diagonal ridges, cross ridges or dead-men, the position of which shall be fixed by the Engineer-in-charge/ /Consultant, shall be left by the

contractor to permit accurate measurements being taken with steel tape on the completion of the work Deduction of such ridges and dead men shall be made from the measurements unless the same are required to be removed later on and the earth so removed is utilized in the work. In the latter case nothing extra will be paid for their removal as subsequent operation.

2.8.4 Where it is not possible or convenient to measure the depth of cutting by recording levels as specified quantity of excavation shall be worked out from filling. The actual measurements of the fill shall be calculated by taking levels of the original ground before start of the work after site clearance and after compaction of the fill as specified and the quantity of earth work so computed shall be reduced by 10% in case of consolidated fills and by 5% in case the consolidation is done by heavy mechanical machinery to arrive at the net quantity of excavation for payment. No such deduction shall, however, be made in case of consolidation by heavy mechanical machinery at optimum moisture content, or when the consolidated filling is in confined situations such as under floors

2.9 SURFACE EXCAVATION

2.9.1 Excavations exceeding 1.5 m in width and 10 sqm. on plan but not exceeding 30 cm. in depth in all types of soils and rocks shall be described as surface excavation and shall be done as specified in

2.9.2 Measurements

The length and breadth shall be measured with a steel tape correct to the nearest cm. and the area worked out to the nearest two places of decimal in square metres.

2.10 EXCAVATION IN WATER. MUD OR FOUL POSITION

2.10.1 All water that may accumulate in excavations during the progress of the work from springs, tidal or river seepage, broken water mains or drains (not due to the negligence of the contractor), and seepage from subsoil aquifer shall be bailed, pumped out or otherwise removed. The contractor shall take adequate measures for bailing and/or pumping out water from excavations and/or pumping out water from excavations and construct diversion channels, bunds, sumps, coffer dams etc. as may be required. Pumping shall be done directly from the foundation trenches or from a sump out side the excavation in such a manner as to preclude the possibility of movement of water through any fresh concrete or masonry and washing away parts of concrete or mortar. During laying of concrete or masonry and for a period of at least 24 hours thereafter, pumping shall be done from a suitable sump separated from concrete or masonry by effective means.

Capacity and number of pumps, location at which the pumps are to be installed, pumping hours etc. shall be decided from time to time in consultation with the Engineer-in-charge/ /Consultant.

Pumping shall be done in such a way as not to cause damage to the work or adjoining property by subsidence etc. Disposal of water shall not cause inconvenience or nuisance in the area or cause damage to the property and structure nearby.

To prevent slipping of sides, planking and strutting may also be done with the approval of the Engineer-in-charge//Consultant

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2.11 SAND FILLING IN PLINTH

2.11.1 Sand

Sand shall be clean and free from dust organic and foreign matter and its grading shall be within the limits of grading zone IV or V specified in Section 3 'Mortars'**.**

2.11.2 Filling

Sand filling shall be done in a manner similar to earth filling in plinth specified in 2.23.3.2. except that consolidation shall be done by flooding with water. The surface of the consolidated sand filling shall be

dressed to the required level or slope and shall not be covered till the Engineer-in-charge/ /Consultant has inspected and approved the sand filling.

2.11.3 Measurements

The length, breadth and depth of consolidated sand shall be measured with steel tape correct to the nearest cm and cubical contents worked out in cubic metres correct to two places of decimal.

2.11.4 Rates

The rates include the cost of material and labour involved in all the operations described above

2.12 ANTI-TERMITE TREATMENT

2.12.0 Sub-terranean termites are responsible for most of the termite damage in buildings. Typically, they form nests or colonies underground. In the soil near ground level in a stump or other suitable piece of timber in a conical or dome shaped mound. The termites find access to the super-structure of the building either through the timber buried in the ground or by means of mud shelter tubes constructed over unprotected foundations.

Termite control in existing as well as new building structures is very important as the damage likely to be caused by the termites to wooden members of building and other household article like furniture, clothing, stationery etc. is considerable. Anti-termite treatment can be either during the time of construction i.e. pre-constructional chemical treatment or after the building has been constructed i.e. treatment for existing building.

Prevention of the termite from reaching the super-structure of the building and its contents can be achieved by creating a chemical barrier between the ground, from where the termites come and other contents of the building which may form food for the termites. This is achieved by treating the soil beneath the building and around the foundation with a suitable insecticide.

2.12.1 Materials

2.28.1.0 ***Chemicals:*** Any one of the following chemicals in water emulsion to achieve the percentage concentration specified against each chemical shall be used:

(i) Chlorphriphos emulsifiable concentrate of 20% (ii) Lindane emulsifiable concentrate of 20%

Anti-termite treatment chemical is available in concentrated form in the market and concentration is indicated on the sealed containers. To achieve the specified percentage of concentration, Chemical should be diluted with water in required quantity before it is used. Graduated containers shall be used for dilution of chemical with water in the required proportion to achieve the desired percentage of concentration. For example, to dilute chemical of 20% concentration. 19 parts of water shall be added to one part of chemical for achieving 1% concentration.

Engineer-in-charge /Consultant shall procure the chemical of required concentration in sealed original containers directly from the reputed and authorized dealers, chemical shall be kept in the custody of the Engineer- in-Charge or his authorized representatives and issued for use to meet the day's requirements. Empty containers after washing and concentrated chemical left unused at the end of the day's work shall be returned to the Engineer-in-charge/Consultant or his authorized representative.

2.12.1.1 ***Measurements: Plint area should be measured***

2.12.2 Safety Precautions

Chemical used for anti-termite treatment are insecticides with a persistent action and are highly poisonous. This chemical can have an adverse effect upon health when absorbed through the skin, inhaled as vapours or spray mists or swallowed.

The containers having emulsifiable concentrates shall be clearly labelled and kept securely closed in stores so that children or pet cannot get at them. Storage and mixing of concentrates shall not be done near any fire source or flame. Persons using these chemical shall be warned that absorption though skin is the most likely source of accidental poisoning. Particular care shall be taken to prevent skin contact with concentrates and prolonged exposure to dilute emulsion shall also be avoided. After handling the concentrates or dilute emulsion. Workers shall wash themselves with soap and water and wear clean

clothing, especially before eating. In the event of severe contamination, clothing shall be removed at once and the skin washed with soap and water. If chemical has splashed into the eyes, they shall be flushed with plenty of soap and water and immediate medical attention shall be sought.

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

Technical Specification for Civil Works Masonry

2.13.1 **Scope**

This Specification covers the materials and workmanship requirements for the construction of brick masonry.

This specification also defines the materials and workmanship requirements for cement pointing sand faced plaster, pebble faced plaster, neat cement punning and water proof plaster.

2.13.2 **Applicable Codes**

The following Indian Standards including all amendments and revisions shall be considered as part of this Specification. Alternative equivalent National Specifications to suit the Country of Origin of the Material, or the country in which the works are constructed may be used but only with the written approval of the Engineer

IS:2386 (Part I) :1963 Method of Test for Aggregate for Concrete : Particle Size and Shape. IS:2386 (Part II) : 1963 Method of Test for Aggregate for Concrete : Estimation of deleterious materials and organic impurities.

IS:2386 (Part III) :1963 method of Test for Aggregate for Concrete : Specific Gravity, Density Voids, Absorption and Bulking.

IS:2116 : 1980Sand for Masonry Mortars.

IS:1542 : 1992 Sand for Plaster

IS:2250 : 1981Code of Practice for Preparation and Use of Masonry Mortar.

IS:3495 Part 1 to 4 : 1992 Methods of Test for Clay Building Bricks.

IS:1077 : 1992 Common Burnt Clay Building Bricks IS:2212 : 1991 Code of Practice for Brickwork

IS:5454 : 1978Method of Sampling of Clay Building Bricks S:1661 : 1972

Code of Practice for Application of Cement and Cement Lime Plaster Finishes.

IS:1597 Part 1 :1992 Code of Practice for Construction of Stone Masonry - Rubble Stone Masonry.

IS:2645 : 2003 Specification for Integral Cement Water Proofing Compounds.

Material

3.1 Bricks

Bricks used shall be of class 7.5 designation conforming to IS:1077. All bricks shall be hand or machine molded and of first class quality, sound, hard, well burnt, of regular and uniform size, shape and colour (generally deep red or copper), homogeneous in texture and free from flaws & cracks. They shall have plain rectangular faces with parallel sides and square

straight

and sharply defined arises. A fractured surface shall show a compact, fine grained uniform and dense texture free from lumps of lime, laminations, cracks, air holes, grits, soluble salts causing efflorescence, or other defects which may in any way impair the strength durability, appearance and usefulness of the brick. A clear metallic sound shall be emitted when two bricks are struck together. After 24 hours immersion in cold water, water absorption by weight shall not exceed 20% of the dry weight of the brick. They shall not break when thrown on ground on their flat surface in saturated condition from height of 1600 mm.

Good bricks locally available and conforming to above can also be used. The tolerance permitted in the accepted size of bricks shall be plus or minus 3 mm in any dimensions. Only bricks of one standards size shall be used on one work unless specifically permitted by the CLIENT Engineer-in-charge/Consultant. Each brick shall have the manufacturer's identification mark or initial mark clearly in the frog. Representative samples of full size bricks shall be submitted for approval before commencing the work.

The compressive strength of bricks shall be minimum of 75 kg per sq. cm. All bricks proposed to be used shall conform to the approved samples in all respects. Any brick found not up to the specification shall be removed from the site immediately by the CONTRACTOR at his own cost.

3.2 Cement

OPC Cement 43 grade cement shall be used conforming to IS:8112 (latest)

3.3 Sand

The sand used shall be natural sand from one approved source. The sand shall be hard, durable, clean and free from adherent coatings, mica, shale, organic matter and appreciable amount of clay,. The sand shall not contain impurities like iron pyrites, alkalis, salts, coal, mica, shell etc. Sand for masonry mortars shall have particle size grading conforming to IS:2116 (latest edition). The grading of sand for used in mortar for unreinforced and reinforced brick work shall be within the specified limited for respective works. The fineness modulus of sand for mortar in unreinforced brickwork shall be between 2.1 to 2.3. A sand whose grading falls outside the specified limited due to excess or deficiency of course or fine particles may be processed to comply with the standard by screening and blending.

3.4 Water

Water shall be clean and free from oil, acid, salt and other injurious materials, Water of soluble quality as per clause 4.3 of IS:456 shall be used.

3.5 Specification of Sand for Masonry and for Plaster

Sand or fine aggregate shall consist of natural sand, crushed stone sand or crushed gravel sand or a combination of any of these. Sand shall be hard, durable, clean and free from adherent coatings and organic matter and shall not contain the amount of clay, silt and fine dust more than specified as under.

3.6Tests for Fine Aggregates

Sand or fine aggregate shall be tested for organic impurities, particle size, silt content and bulking in accordance with IS: 2386 Part I, II and III.

Storage of Materials

4.1 Bricks

Bricks shall not be dumped at site. They shall be stacked in regular tiers, even as they are unloaded to minimise breakage and defacements. The supply of bricks shall be so arranged that at least three days requirements of bricks are available at site at any point of time. Bricks selected for use in different location of use in the work shall be stacked separately.

4.2 Cement & Sand

Cement and sand shall be stored as specified in clause 4.0 of specification for plain and reinforced concrete.

Mortar

5.1 Cement Mortar

Mortar for brick work shall be prepared in accordance with IS: 2250.

5.1.1 Proportioning

Cement bag weighing 50 kg shall be taken as 0.035 cubic metre. Other ingredients in specified proportion shall be measured using boxes of size 40 x 35 x 35 cm. Sand shall be measured on the basis of its dry volume.

5.1.2 Mixing

The mixing of mortar shall be done in mechanical mixers operated by power or manually as decided by the Engineer. The Engineer may however, permit hand mixing at his discretion taking into account the nature, magnitude and location of the work and practicability of the use of mechanical mixers or where item involving small quantities are to be done or if in his opinion the use of mechanical mixers is not feasible.

In cases, where mechanical mixers are not to be used, the Contractor shall take permission of the Engineer in writing before the commencement of the work.

5.1.3 Mechanical Mixing

Cement and sand in the specified proportions shall be mixed dry thoroughly in a mixer. Water shall then be added gradually and wet mixing continued for at least three minutes. Only the required quantity of water shall be added which will produce mortar of workable consistency. Only the quantity of mortar which can be used within 30 minutes of its mixing shall be prepared at a time. Mixer shall be cleaned with water each time before suspending the work.

5.1.4 Hand Mixing

The measured quantity of sand shall be levelled on a clean masonry platform and cement bags emptied on top. The cement and sand heap shall be thoroughly mixed dry by being turned over and over, backwards and forwards, several times till the mixture is of a uniform colour. The quantity of dry mix which can be used within 30 minutes shall then be mixed in a masonry trough with just sufficient quantity of water to bring the mortar to a stiff paste of necessary working consistency approval for hand mixing shall be taken from Engineer in Charge/Consultant

5.1.5 Precautions

Mortar shall be used as soon as possible after mixing and before it begins to set, and in any case within half an hour, after the water is added to the dry mixture.

Brick Masonry (Burnt Clay Brick)

6.1 Bricks used in masonry shall be common burnt clay bricks conforming to IS 1077

Bricks shall have min. average compressive strength of 7.5 N/mm2 i.e. class 7.5

6.2 General Quality

Bricks shall be hand moulded or machine moulded and shall be made from suitable soils. They shall be free from cracks and flaws and nodules of free lime. The bricks shall have smooth rectangular faces with sharp corners and shall be uniform in colour and shall emit ringing sound when struck simply.

6.3 Burnt Clay Brick Work

Brick work shall generally conform to IS 2212.

6.3.1 Laying

Brick work shall be constructed in cement mortar 1:5 or as specified. Lime shall not be used where reinforcement is provided in brick work.

6.3.2 Laying

6.3.2.1 Bricks shall be laid in English Bond unless otherwise specified.

Half or cut bricks shall not be used except as closers to complete the bond. Closers in such cases, shall be cut to the required size and used near the ends of the wall. Header bond shall be used preferably in all courses in curved plan for ensuring better alignment.

Note

Header bond shall also be used in foundation footings unless the thickness of walls (width of footing) makes the use of headers impracticable. Where the thickness of footing is uniform for a number of courses, the top course of footing shall be headers.

6.3.3 Curing

The brick work shall be constantly kept moist on all faces for a minimum period of seven days. Brick work done during the day shall be suitably marked with the date on which the work is done to monitor the curing period.

6.3.4 Scaffolding

Scaffolding shall be strong enough to withstand all dead, live and impact loads which are likely to come on them. Scaffolding shall be provided to allow easy approach to every part of the work.

6.4 Half Brick Work

Brick work in half brick walls shall be constructed in the same manner as described in Clause 6.3.4 Except that the bricks shall be laid in stretcher bond.

These walls shall be constructed in cement mortar 1:4. Lime mortar shall not be used.

75 mm thick RCC M15 beams (patli beams) with 2 numbers 8 mm dia high strength deformed bars shall be provided at a vertical spacing of 1 metre.

The reinforcement shall be securely anchored at the end of the wall. The free ends of reinforcement shall be keyed into the mortar of the main work to which the half brick work is joined. Laps in reinforcement if any shall not be less than 30 cm.

Depending on the dimensions of the wall, 200 mm x 115 mm RCC mullions at every 3 metres and at corners shall be provided with reinforcement of 4 numbers 8 mm diameter high strength deformed bars. The steel in the horizontal beams in such cases will run through these mullions.

These partition walls shall be constructed in two stages. In the first stage, brick work with binders shall be constructed leaving gaps equal to and at the locations of the mullions. In the second stage mullions shall be constructed.

Fly Ash Bricks

7.1. Applicable Codes

The following Indian Standards including all amendments and revisions shall be considered as part of this Specification.

IS:712 : 1984 Specifications for building limes (third revision)

IS:1727 : 1967 Methods of Test for pozzolanic materials (first revision)

IS:3495 (Part 1) :1992 Determination of compressive strength (second revision)
IS: 3495 (Part 2): 1992
Determination of water absorption (second revision) IS: 3495 (Part 3): 1992
Determination of Efflorescence (second revision) IS: 3812:1981
Specification of fly ash for use as pozzolana & admixture (first revision) IS: 4139:1989
Specifications for calcium silicate bricks (second revision) IS: 5454: 1978
Methods for sampling of clay burnt building bricks (first revision)

7.2 Classification

Pulverized fuel ash lime bricks shall be classified on the basis of average wet compressive strength. Bricks used shall be of class 5 (50 kgf/cm2) designation confirming to IS 12894-
20
02

7.2.1 Materials

7.1.2.1 Pulverized Fuel Ash : Pulverized Fuel Ash confirm to Grade 1 or Grade 2 of IS 3812

7.1.2.2 Bottom Ash : Bottom Ash used as replacement of sand shall not have more 12 % loss on ignition when tested according to IS 1727.

7.1.2.3 Sand : Deleterious materials such as clay & silt in sand shall preferably less than 5 %.

7.1.2.4 Lime : Lime shall confirm to class C hydrated lime of IS 712.

7.1.2.5 Additives: Any suitable additive considered not detrimental to the durability of the bricks such as gypsum, cement,etc. may be used.

7.3 AAC BLOCK

7.3.1 Scope

This standard (Part3) covers the requirements of autoclaved cellular (aerated) concrete block having density up to 1000 Kg cum

Applicable Codes

The following Indian Standards including all amendments and revisions shall be considered as part of this Specification.

IS:2185 : 1984 Part-3 Specifications Autoclaved cellular(Aerated) Concreate Block

7.3.2 Dimensions and Tolerances

Concrete blocks shall be its nominal dimensions
Length 400,500 or 600mm
Height 200,250,or 300
Width 100,150,200,or 250mm

The maximum variation in the length of the units shall not be more than + -5mm and maximum variation in the height and width of unit not more than + -3mm

7.3.3 Classification

The autoclaved cellular concreate blocks shall be classified in two grades according to their compressive strengths as indicated in table

Physical Properties of Autoclaved cellular concrete block

Table-1

S no	Density in oven dry condition	Compressive strength Grade-1	Compressive strength Grade-2	Thermal Conductivity in air dry condition
	Kg/cum	N/sqmm	N/sqmm	W/m.k
i	451to 550	2.0	1.5	0.21
ii	551to 650	4.0	3.0	0.24
iii	651 to 750	5.0	4.0	0.30
iv	751 to 850	6.0	5.0	0.37
v	85 to 1000	7.0	6.0	0.42

Drying Shrinkage – The drying shrinkage shall be not more than 0.05percent for grade 1blocks and 0.10 percent for grade 2

7.4 Tests

The block density shall be determined in the manner described in IS:6441(part 1)-1972

The block compressive strength shall be determined in accordance with IS:6441(part 5)-1972

The block Thermal conductivity shall be determined in accordance with IS:3346-1980

The block drying shrinkage shall be determined in accordance with IS: 6441(part 2)-1972

7.5 STORAGE

General requirement of storage of autoclaved cellular (aerated) concreate blocks shall be as described in IS: 4082-1977

Plastering

Plastering shall generally conform to IS:1661.

8.1 Sand Faced Plaster

8.1.1 Surface Preparation

The joints shall be raked out properly and dust and loose mortar shall be brushed out. Efflorescence, if any shall be removed by brushing out and scraping. The surface shall then be thoroughly washed with water, cleaned and kept wet before plastering is commenced.

8.1.2 Application of Plaster

8.1.2.1 Plaster shall be applied in two coats namely, 12 mm undercoat and 8 mm finishing coat. Ceiling plaster shall be completed before commencement of wall plaster. Plastering shall be started from top and worked down towards floor. All holes shall be properly filled in advance of plastering.

8.1.2.2 Plaster shall be applied with force either manually or by mechanical means. 12 mm thick undercoat - First plaster of 12 mm thick and 150 x 150 mm shall be applied horizontally and vertically, at not more than 2 m intervals over entire surface to serve as gauges. The plaster shall be applied in a uniform surface slightly more than 12 mm thick and then brought to a true surface, by working a wooden straight edge reaching across the gauges, with small upwards and sideways movements at a time. The surface shall be left rough and furrowed 2 mm deep with scratching tool diagonally both ways, to form keys for the finishing coat. The surface shall be kept wet till finishing coat is applied.

Mortar for undercoat shall be 1cement + 5sand (1:5) by volume.

8.1.2.3 8 mm Finishing Coat - The finishing coat shall be applied after the undercoat has sufficiently set but not dried and in any case within 48 hours. Sand to be used for second coat shall be sieved. Sand passing through 3 mm sieve shall be taken for the second coat.

The sand shall be of uniform size so that when sieved through a sieve of 50 mesh not more than 10% shall pass through. The second coat shall be struck uniformly over the first coat and firmly pressed and levelled using a batten. The surface shall then be firmly trowelled and sponge floated to remove excess moisture and bring the sand to the surface. The surface thus prepared shall be uniformly roughened for texture, by running a fine wire brush lightly over the surface if necessary.

Mortar to be used for this coat shall be 1cement + 2sand, by volume.

The surface of plaster shall be kept wet for at least 7 days and shall be protected from the sun.

8.1.2.4 General - All corners, angles, arises and junctions shall be truly vertical and horizontal as the case may be and shall be carefully finished. Rounding or chamfering corners, arises,

angles etc. where required shall be done. Such rounding or chamfering shall be carried out with proper templates to the size required.

When work is suspended at the end of the day, the plaster shall be left, cut clean to line both horizontally and vertically. When plastering is resumed, the edge of the old work shall be scraped, cleaned and wetted with water before plaster is applied to the adjacent areas. Plastering work shall be closed at the end of the day on the body of the wall and not nearer than 150 mm to any corners or arises.

It shall not be closed on the body of features like bands, cornices etc. and not at the corners.

The curing shall be started as soon as the plaster has hardened sufficiently not to be damaged when watered. The plaster shall be kept wet for a period of at least 7 days.

During this period, it shall be suitably protected from damage by such means as the Engineer may approve. The dates on which plastering is done shall be legibly marked on the various sections plastered to help monitor the curing period.

For plastering work, double scaffolding having two sets of vertical supports shall be provided so that scaffolding is independent of walls. The Contractor shall provide and maintain scaffolding sufficiently strong to withstand all likely loads.

8.2 Rough Cast Plaster

The surface preparation, application and curing shall be same as described for sand faced plaster for the undercoat. Mortar for the finishing coat shall consist of one part of cement plus one part of well graded sand plus one part of gravel of 3 mm to 6 mm size.

Mortar shall be thrown on the wall by means of a scooper or plasterer's trowel. The thickness of the coat shall be about 10-12 mm. Curing shall be carried out for seven days.

8.3 Neat Cement Punning

Before application of punning the surface shall be made true. All the put log holes, crevices etc. shall be filled in properly. Then the entire area shall be uniformly treated with a neat paste of cement and rubbed smooth, so that the entire surface is covered with neat cement coating. The quantity of cement applied shall be 1 kg per square metre.

Smooth finishing shall be completed with trowel immediately and in no case later than half an hour after adding water to the plaster mix.

8.4 Waterproof Plaster

Integral cement waterproofing compounds of approved make and manufacture shall only be used for plastering. These compounds shall generally conform to IS:2645.

Material shall be brought to the site in its original packing. The containers shall be opened and contents shall be mixed with dry cement in the proportion and manner as specified by the manufacturer. Care shall be taken in mixing, to see that waterproofing material gets well and integrally mixed with cement and does not run out separately on addition of water.

Quality Assurance

9.1 The CONTRACTOR shall submit the quality assurance plan/ inspection test plan to INDIAN STANDARDS for review & approval for the above items of works and shall take all necessary steps for compliance.

9.2 The CONTRACTOR shall carry out any test on material as desired by the CLIENT Engineer-in-charge/Consultant in order to satisfy him regarding quality without any additional cost.

Technical Specification for Plain and Reinforced Cement Concrete Works

• Scope

This specification establishes the minimum requirements of materials, quality, batching, mix proportioning, transporting, placing, protecting, curing, repairing, finishing & testing etc. of all types of cast-in-situ and precast concrete used in foundations, underground and aboveground structures, floors, pavements etc. Any special requirements as shown or noted on the drawings shall supersede over the provisions of this specifications.

• Applicable Codes

Apart from this specification, construction of plain and reinforced concrete works shall be in accordance with the Indian Standard Code of Practice for "Plain and Reinforced Concrete" IS:456 and other relevant codes mentioned therein.

The following Indian Standards including all amendments and revisions shall be considered as part of this specification

IS: 8112	Specification for Ordinary Portland cement
IS: 383 : 1970	Specification for Coarse & fine aggregates from natural sources for concrete
IS: 432 : 1982	Specification for mild steel and (Part I & II) medium tensile steel bars and hard drawn steel wire for concrete reinforcement.
IS: 455 : 1989	Specification for Portland Blast Furnace Slag cement.
IS: 456 : 2000	Code of Practice for Plain and Reinforced Concrete.
IS: 516 : 1959	Methods of Tests for Strength of Concrete.
IS: 650 : 1991	Specification for standard sand for testing of cement.
IS:1139 : 1966	Specification for hot rolled mild steel and medium tensile steel deformed bars for concrete reinforcement.
IS:1199 : 1959	Methods of Sampling and Analysis of Concrete.
IS:1200 : 1992	Methods of measurement of building works.
IS:1489 : 1991	Specification for Portland Pozzolona Cement.
IS:1566 : 1982	Specification for plain hard drawn steel wire fabric for concrete reinforcement.
IS:1786 : 1985	Specification for High Strength Deformed Steel Bars and Wires for Concrete Reinforcement.
IS:1791 : 1985	Specification for Batch Type Concrete Mixers.
IS: 2386 : 1963	Methods of Test for Aggregates for Concrete: Part 3, Specific gravity, density, voids, absorption and bulking.
IS: 2396(I) : 1988	Flakiness index of aggregates
IS:2502 : 1963	Code of Practice for Bending and Fixing of Bars for Concrete Reinforcement.
IS:2505 : 1992	Specification for concrete vibrator immersion type.
IS:2645 : 2003	Specification for integral cement water proofing material.

IS:2750 : 1964	Specification for steel scaffolding
IS:2751 : 1979	Recommended Practice for Welding of Mild Steel Plain and Deformed Bars for Reinforced Concrete Construction.
IS:2772 : 1982	Specification for portable swing weigh-batchers for concrete
IS:3696 : 1987	Safety code for scaffolding and ladders
IS:4014 : 1967	Code of Practice for steel tubular (Part I & II) Scaffolding
IS:4031 : 1988	Method of physical tests for hydraulic cement
IS:4926 : 2003	Ready Mixed Concrete
IS:4990 : 1993	Specification for plywood for concrete shuttering work
IS: 7861	Code of Practice for Extreme Weather Concreting.
IS:9013 : 1978	Methods of Making, Curing and Determining Compressive Strength of Accelerated Cured Concrete Test Specimens.
IS:9103 : 1999	Specification for Admixtures for Concrete.
IS:9417 : 1989	Recommendation for Welding Cold Worked Steel Bars for Reinforced Concrete Construction.
IS:10262 : 1982	Recommended Guidelines for Concrete Mix Design.
IS:14687 : 1999	Guidelines for Formwork for Concrete Structures.

- # Materials

3.1 Cement

Ordinary Portland Cement shall conform to IS: 8112, Portland Blast Furnace Slag Cement shall conform to IS: 455. Use of Portland Pozzolana Cement shall be only with prior approval of the Engineer Engineer-in-charge/Consultant

3.2 Aggregates

Aggregates in general designate both fine and coarse inert materials used in the manufacture of concrete. The fine aggregate is aggregate which passes through 4.75 mm IS Sieve. Coarse aggregate is aggregate most of which is retained on 4.75 mm IS Sieve.

All aggregates shall conform to IS: 383. Fine aggregate shall consist of natural sand, i.e. river or pit sand. Coarse aggregate shall consist of crushed gravel, natural gravel, crushed stone or combination thereof conforming to requirements of grading and physical properties called for. However, bank run gravel shall not be permitted for coarse aggregates.

The fineness modules of sand should be between 2.2 to 3.2 for concrete works.

The maximum size of coarse aggregate shall be 38 mm except for slabs and walls less than
250 mm thick which shall have a maximum size of 19 mm.

Blast furnace slag and manufactured sand shall not be used as aggregates.

3.3 Water

Water used for both mixing and curing shall be free from injurious amounts of deleterious materials and shall be of potable quality conforming IS: 456.

3.4 Brick Aggregates

The brickbats shall be new bricks well burnt, hard durables, broken to sizes and well graded.

It shall be free from dust, earth and any other impurities.

3.5 Reinforcement

Reinforcement shall be of tested quality M.S. round rods conforming to IS:432, IRC wire mesh fabric conforming to IS:1566, mild steel and medium tensile steel deformed bars conforming to IS:1139 and cold twisted steel bars conforming to IS:1786 as shown in drawings.

All reinforcement shall be clean, free from grease, oil, paint, loose mill scale, loose rust, dust, bituminous material or any other material or substance that will destroy or reduce the bond.

16 SWG (1.6 mm) approved soft annealed steel wire shall be used for binding the reinforcement bars.

3.6 Water Stoppers

Metallic water stopper shall be fabricated from 22 gauge G.I. sheet of specified width and bent, folded to shape, soldered and fixed. The transverse joints of the sheets shall either be welded, brazed or overlapped. In case of overlapping of the stoppers the minimum overlap should be equal to width of such water stopper.

PVC and rubber water stops shall be either ribbed or serrated type having a minimum thickness of 8 mm. These can be of approved make, such as "PASK", "CALICO",MARUTI" or approved equivalent. They shall be accurately cut, fitted and integrally joined as per manufacturer's specifications.

3.7 Jointing/Sealing Materials

All joint fillers, sealing materials etc. used for joints in concrete shall be from approved standard manufacturer and shall conform to relevant IS codes. The extent, type, method of use and control shall be as per manufacturer's recommendation, subject to approval of the Engineer-in-charge/Consultant.

3.8 Admixtures

Admixtures shall be used strictly in accordance with the manufacturer's instructions and shall conform to the relevant IS codes (for eg. IS: 9103). Vendor's instruction shall be successfully incorporated in the trial mix. The extent, type, method of use and control shall be subject to approval of the Engineer -in-charge/Consultant in all cases.

Integral water proofing compound shall conform to IS: 2645.

4. Storage of Materials

4.1 Cement

Cement shall be stored in a damp-proof hopper or in sealed bags in a weather proof shed, on a floor above ground and shall be used in the order of its delivery. Different types or brands of cement shall be stored separately. Not more than 12 bags shall be stacked in any tier.

4.2 Aggregates

Aggregates of different sizes shall be kept separately. Aggregates of similar grading but from different sources or different types shall not be stored together unless approved. All aggregates shall be stored in such a way that they are free from contact of deleterious matter.

4.3 Reinforcing Steel

Reinforcing steel members and wire mesh which are stored at the project site shall be above ground on platforms, skids or other supports.

Steel shall be protected from rain, moisture and kept free from dirt, oil or contaminant injuries.

4.4 Miscellaneous

All other materials shall be stored in a weather tight and dry place and be protected from open flame or sparks.

All packed materials shall be stored in their original unbroken package or container.

- # Grades of Concrete

Unless otherwise noted on the drawings, or called for in the schedule of rates, the grades of concrete shall generally be as per Table-1.

TABLE - 1 GRADES OF CONCRETE	
Grade Designation	**Specified Characteristic Compressive Strength of 150 mm**
M 7.5	7.5
M 10	10
M 15	15
M 20	20
M 25	25
M 30	30

Note for Table - 1 :

The characteristic strength is defined as the strength of material below which not more than five (5) percent of the test results are expected to fall.

In the designation of concrete mix the letter 'M' refers to the mix and the number to the specified characteristic compressive strength of 15 cm cube at 28 days expressed in N/sq. mm.

5. Grades of Concrete

TABLE - 1 GRADES OF CONCRETE	
Grade Designation	**Specified Characteristic Compressive Strength of 150 mm**

M 7.5	7.
M 10	5
M 15	1 0
M 20	1
M 25	5
M 30	2

Unless otherwise noted on the drawings, or called for in the schedule of rates, the grades of concrete shall generally be as per Table-1.

Note for Table - 1 :

The characteristic strength is defined as the strength of material below which not more than five (5) percent of the test results are expected to fall.

In the designation of concrete mix the letter 'M' refers to the mix and the number to the specified characteristic compressive strength of 15 cm cube at 28 days expressed in N/sq. mm.

6. Type of Concrete Mix

6.1 General

Unless otherwise noted on drawings, all lean/plain and reinforced concrete shall be nominal mix and design mix types, respectively.

6.2 Nominal Mix Concrete

This concrete shall be made (without preliminary tests) by adopting nominal concrete mix with proportions of materials as specified in Table-1 A

TABLE - 1A
PROPORTIONS FOR NOMTNAT. MIX CONCRETE

Nominal mix of concrete (by mass)	Quantity of water per 50 kg of cement (max) Litres
1:5:10	60
1:3:6	34
M 15(1:2:4)	32
M 20(l:1l/2:3)	34

Note:

1. The proportions of the fine to coarse aggregates should be adjusted from upper limit to lower limit progressively as the grading of the fine aggregates becomes finer and the maximum size of coarse aggregates becomes larger. Graded coarse aggregates shall be used.
2. The cement content of the mix shall be proportionately increased if the quantity of water in a mix has to be increased to overcome the difficulties of placement and compaction, so that the water-cement ratio, as specified, is not exceeded.

6.3 Design Mix Concrete

The mix shall be designed to produce the grade of concrete having the required workability

and characteristic strength not less than appropriate values given in Table-1. The target mean strength of concrete mix shall be equal to the characteristic strength plus 1.65 times the standard deviation.

As long as the quality of materials does not change, a mix design done earlier may be considered adequate for later work. However, in case the quality of materials changes or there is a break in the continuity of construction and the same work is allocated to a new contractor,the Engineer -in-charge/Consultant shall ask for a new design mix.

Irrespective of the grade of concrete required to be produced as per characteristic.

The strength criteria, the minimum cement content and maximum free water cement ratio in the design concrete shall be strictly maintained as stipulated in Table 2A for the corresponding grade of concrete.

The contractor at his own cost; grade the aggregates and control the water/cement ratio, design & conduct the different trial mixes to required strength and workability & obtain Engineer-in charge's approval for the same. Duly approved mixes in accordance with IS: 456 shall be used for construction.

All concrete shall be machine mixed and no hand mixing shall be permitted. The concrete shall continuously agitate from mixing to pouring. The use of non agitating equipment in transporting ready mixed concrete or the use of partially hardened concrete is not allowed.

Where reinforcement is too closely spaced for the maximum size of aggregate in a range, the largest suitable range will be used with the approval of the Engineer-in-charge/Consultant

7. Concrete Mix Proportioning

Proportioning, as used in this specification, shall mean the process of determining the proportions of the various ingredients to be used to produce concrete of the required workability when fresh/green and strength, durability and surface finish, when hardened. The following information shall be collected prior to design of the concrete mix :

a) Grade designation b) Type of cement

c) Maximum nominal size of aggregate d) Minimum cement content

e) Maximum free water cement ratio

f) Workability requirements.

The CLIENT Engineer-in-charge/Consultant shall verify the strength of the concrete mix, before giving his sanction of its use. However, this does not absolve the Contractor of his responsibility as regards achieving the prescribed strength of the mix. If during the execution of the work, cube tests show lower strengths than required, the CLIENT Engineer-in- Charge shall

order fresh trial mixes to be made by the Contractor. No claim to alter the rates of concrete work shall be entertained due to such changes in mix variations. Any variation in cement consumption shall be taken into consideration for material reconciliation. Preliminary mix designs shall be established well ahead of start of work.

7.1 Maximum Density

Suitable proportions of sand and the different sizes of coarse aggregates for each grade of concrete shall be selected to give as nearly as practicable the maximum density. This shall be determined by mathematical means, laboratory tests, field trials and suitable changes in aggregate gradation. The contractor shall submit to the CLIENT Engineer-in-charge/Consultantat least three sets of mix design and corresponding test results after varying the mix proportions and / or grading of aggregate so as to establish the maximum density of any particular grade of concrete.

7.2 Free Water Cement Ratio

Once a mix, including its free water cement ratio, has been determined and approved for use by the Engineer-in- Charge, that free water cement ratio shall be maintained. The Contractor shall determine the water content of the aggregates frequently as the work progresses, and the amount of mixing water shall be adjusted so as to maintain the approved free water cement ratio.

7.3 Consistency

The concrete shall have a consistency such that it shall be workable in the required position and when properly vibrated it flows around reinforcing steel, all embedded fixtures, etc.

The consistency of concrete shall have to be controlled as per IS: 456 and the slump tests shall be carried out by the contractor in accordance with IS: 1199.

7.4 Workability

7.4.1 The concrete mix proportion shall be such that the concrete is of adequate workability for the placing condition and can be properly compacted with the means available. Use of additives of approved make shall be taken recourse to where required for attaining proper workability as specified under Cl. 7.4.2.

7.4.2 The suggested ranges of values of workability of concrete measured in accordance with IS:1199 are indicated in Table-2 below. However, the actual values to be followed shall be established depending on aggregate sizing, mix proportions, placing conditions, etc and shall be got approved by the CLIENT Engineer-in-charge /consultant. At least one slump test shall be carried out per every compressive test performed. More frequent tests shall be made if there is a distinct change in work conditions, if required byCLIENT Engineer-in-charge Consultant

TABLE - 2
Values of Workability

Placing conditions	Degree of workability	Slump (mm)

Lightly reinforced sections in slabs, beams, walls, columns, footings and pavements	Low	25-75
Heavily reinforced sections in slabs, beams, walls, columns, slip- form work and pumped concrete.	Medium	50-100
In-situ piling	High	100-150
Tremie concrete	Very High	150-200

7.5 Durability

For achieving sufficiently durable concrete, strong, dense aggregates, low water-cement ratio and adequate cement content shall always be used. Workability of concrete shall be such that concrete can be completely compacted with the means available. Leak-proof formwork shall be used so as to ensure no loss of cement-slurry during pouring and compaction. Cover to reinforcement shall be uniform and as shown on drawings. Concrete mix design shall always take into account the type of cement, minimum cement content irrespective of the type of cement and maximum free water cement ratio and minimum grade of concrete conforming to the exposure conditions as given in Table-2A

TABLE -2A
Minimum Cement Content, Maximum Free Water Cement Ratio and Minimum Grade of Concrete for Different Exposure Conditions

Exposure	Plain Concrete			Reinforced Concrete		
	Minimum Cement Content (kg/m^3)	Maximum Free Water Cement Ratio	Minimum Grade of Concrete	Minimum Cement Content (kg/m3)	Maximum Free Water Cement Ratio	Minimum Grade of Concrete
Mild	240	0.6	M 15	330	0.55	M 20
Moderate	265	0.6	M 15	330	0.50	M 25
Severe	275	0.5	M 20	350	0.45	M 30
Very Severe	280	0.45	M 20	375	0.45	M 35
Extreme	310	0.4	M 20	400	0.4	M 40

Generally, the following types of cement shall be used for Plain and Reinforced concrete works:

a) 43 Grade Ordinary Portland cement conforming to IS: 8112: 1989

b) Portland Slag Cement conforming to IS: 455.

c) Portland Pozzolana Cement conforming to IS: 1489.

d) Sulphate Resisting Portland cement conforming to IS: 12330: 1988

Sulphate Resisting Portland Cement shall be used only for specific requirements depending on environmental and process exposure conditions to which the structures may be subjected to like high sulphate concentrations, processes involving sulphur handling etc.

The minimum cement content as mentioned in Table-2A shall be adjusted for aggregates

other than 20mm nominal maximum size. The minimum cement content in the concrete mix shall be increased by 40kg/m3 and decreased by 30 kg/m3 for 10mm and 40mm nominal maximum size aggregates respectively.

8. Batching

8.1 In proportioning concrete, the quantity of both cement and aggregate shall be determined by mass. Where the mass of cement is determined on the basis of mass of cement per bag, a reasonable number of bags shall be weighed periodically to check the net mass. Where the cement is weighed at site and not in bags, it shall be weighed separately from the aggregates. Water shall be either measured by volume in calibrated tanks or weighed. Any solid admixtures that are to be added shall be measured by mass; liquid and paste admixtures shall be measured by volume or mass. Batching plant, shall conform to IS:4925: 2004 All measuring equipment shall be maintained in a clean serviceable condition, and their accuracy shall be within ±2% and ±3%for measurement of cement and aggregates/water/admixtures, respectively.

8.2 Under very special circumstances change from weigh batching to appropriate volume batching may be permitted by CLIENT Engineer-in-charge/Consultant/. However, in such cases all conversions from mass of ingredients to volume shall be based on actual and appropriate bulk densities physically measured at site and approved by the Engineer-in-charge/ consultant.

8.3 No substitutions in materials used on the work or alterations in the established proportions, except as permitted in 7.4 shall be made without additional tests to show that the quality and strength of concrete are satisfactory. In case the Contractor proposes any change in the already approved mix design, fresh mix design with supportive laboratory tests shall be submitted to the CLIENT Engineer-in-charge/Consultant and his approval has to be obtained prior to using the revised mix proportion in the works. However, such proposals for revision shall only be entertained in case of successive failure of test cubes to achieve the required strength.

9. Concrete Mixing

9.1 General

The mixing of concrete shall be strictly carried out in an approved type of mechanical concrete mixer. The mixer shall be fitted with water measuring devices. The mixing shall be continued until there is a uniform distribution of the material and the mass is uniform in colour and consistency. If there is segregation after unloading from the mixer, the concrete shall be remixed.

Use of Ready Mixed Concrete supplied by Ready Mixed Concrete Plants or from on/off-site batching plants (IS: 4926) shall be preferred for structural concrete.

All records and charts for the batching and mixing operations shall be prepared and maintained by the contractor as per the instructions of CLIENT Engineer-in-charge/ consultant.

Mechanical Mixers shall comply with IS: 1791 and 12119: 2004 and shall be maintained in satisfactory operating condition.
Hand mixing of concrete shall not be permitted. However, for non-critical applications namely foundations for crossovers, isolated operating platforms etc. using concrete of maximum grade M20 and located at far away isolated places, this may be permitted by the Engineer-in-charge/Consultants a special

9.2 Additives

Additive in concrete shall be used only with the prior approval of the Engineer- in-Charge and shall comply with IS: 456. Any additive used for obtaining proper workability or leak-

proofness of concrete or repair/rendering works of concrete due to non-conformance to the specifications, shall not be measured and paid for. All costs relating to such usage shall be borne by the Contractor.

10. Transportation, Placing and Compaction

10.1 General

The entire concrete placing programme including transportation arrangements, deployment of equipment, layout, proposed procedures and methods, shall be submitted tothe Engineer-in-charge/Consultant24 hours prior to concreting for approval. No concreting shall be placed until his approval has been received. Approval of the CLIENT Engineer-in-charge/Consultant for pouring concrete shall be taken as 'conveyed', when the concrete pour card is signed by him.

10.1.1 Vibrators

10.1.1.1 In placing concrete in layers which are advancing horizontally as the work progresses, great care shall be exercised to ensure adequate vibration, bonding and moulding of the concrete between the succeeding batches.

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

10.1.1.3 Care shall be taken to prevent contact of vibrators against all embedded reinforcing steel or inserts. Vibrators shall not be allowed to come in contact with forms.

10.1.2 Transportation

10.1.2.1 All concrete shall be conveyed from the mixer to the place of final deposit such as formwork as early as possible using suitable buckets, dumpers, pumps, transit mixers containers or conveyors which shall be mortar leak tight. Care shall be taken to prevent the segregation or loss of the ingredients and maintaining the required workability. For structural concrete produced from Ready Mixed Concrete Plants as per Cl. 9.1, concrete shall be transported from the plants to the sites only by transit mixers.

10.1.3 Placing and Compaction

10.1.3.1 Before placing concrete, all soil surfaces upon which or against which concrete is to be placed shall be well compacted and free from standing water, mud or debris. Soft or yielding soil shall be removed and replaced, with lean concrete or with selected soils/sand and compacted to the density as directed by CLIENT Engineer-in-charge /consultant. The surface of absorptive soil (against which concrete is to be placed) shall be moistened thoroughly so that moisture is not drawn from the freshly placed concrete. Similarly, for concrete to be placed on formworks, all chippings, shavings and sawdust etc. shall be removed from the interior of the forms before the concrete is placed.

Concrete shall be placed within a maximum period of 25 minutes of its removal from mixture.

10.1.3.2 Concrete shall not be placed until the formwork, the placement of reinforcing steel, embedded parts, pockets etc. Have been inspected and approved by the Engineer- in-Charge. Any accumulated water on the surface of the bedding layer shall be removed by suitable means before start of placement. No concrete shall be placed on a water covered surface

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10.1.4 Items Embedded in Concrete

10.1.4.1 Concreting shall not be started unless the electrical conduits, pipes, fixtures etc., wherever required, are laid by the concerned agency. The Contractor shall afford all the facilities and

maintain co-ordination of work with other agencies engaged in electrical and such other works as directed by the Engineer-in-charge/ consultant.

10.1.4.2 Before concreting, the Contractor shall provide, fabricate and lay in proper position all metal inserts, anchor bolts, pipes etc. (which are required to be embedded in concrete members) as per relevant drawings and directions of CLIENT Engineer-in-charge/ consultant.

10.1.4.3 Anchor bolts shall be set to template and firmly tied/fixed in vertical & horizontal line at all required positions.

10.1.4.4 All embedment, inserts etc. shall be fully held and secured in their respective positions by the concerned agencies to the entire satisfaction of CLIENT Engineer-in-charge/Consultants as to avoid any dislocation or displacement during the concreting operations. The Contractor shall take all possible care during concreting to maintain these embedment/inserts in their exact locations.

11. Construction Joints

11.1 Construction joints shall be provided in position as shown or described on the drawings or as directed by the Engineer-in-charge/Consultant. Such joints shall be kept to the minimum. These shall be straight and at right angles to the direction of main reinforcement and shall be placed at accessible locations to permit cleaning out of laitance, cement slurry and unsound concrete.

11.2 In a column, the joint shall be formed about 100mm to 150mm below the lowest soffit of the beams framing into it. Concrete in a beam and slab shall be placed throughout without a joint but if the provision of a joint is unavoidable, the joint shall be vertical and located within 1/3 to 1/4 of the span, unless otherwise shown on the drawings.

11.3 When stopping the concrete on a vertical plane in slabs and beams, an approved stop board shall be placed with necessary slots for reinforcement bars. The construction joints shall be keyed by providing a triangular or trapezoidal fillet nailed on the stop board. Inclined joints shall not be permitted. Any concrete flowing through the joints of stop board shall be removed soon after the initial set. When concrete is stopped on a horizontal plane, the surface shall be roughened and cleaned after the initial set and a triangular or trapezoidal groove shall be provided for keying with the new concrete later.

12. Expansion Joints / Isolation Joint

12.1 Expansion/ Isolation joints in structures shall be formed in the positions and to the shapes shown in the relevant drawings. Joints shall be filled with joint filling material as stipulated in the drawings/schedule of rates. Isolation joints shall be provided around all equipment foundations, columns, pedestals, trenches etc. on grade.

13. Protection of Freshly Laid Concrete

13.1 Newly placed concrete shall be protected, by approved means, from rain, sun and wind. Concrete placed below the ground level shall be protected from falling earth during and after placing. Surface shall be kept free from contact with such ground or with water draining from such ground during placing of concrete for a period of at least 3 days, unless otherwise directed by the CLIENT Engineer-in-charge/Consultant. The ground water around newly poured concrete shall be kept to an approved level by pumping or other approved means of drainage and adequate steps shall be taken to prevent floatation and flooding. Steps shall be taken to protect immature concrete from damage by debris, loading, vibration, abrasion, mixing with deleterious materials that may, in the opinion of the CLIENT Engineer-in-charge/ /consultant, impair the strength and/or durability of the concrete.

14. Curing

14.1 Concrete shall be cured by keeping it continuously moist wet for the specified period of time to ensure complete hydration of cement and its hardening. Curing shall be started after 8 hours of placement of concrete in normal weather, and in hot weather after 4 hours. The water used for curing shall be of the same quality as that used for making of concrete.

Curing shall be assured by use of an ample water supply under pressure in pipes, with all necessary appliances such as hose, sprinklers etc. A layer of sacking, canvas, hessian, or other approved material, which will hold moisture for long periods and prevent loss of moisture from the concrete, shall be used as covering. Type of covering which would stain, disfigure or damage the concrete, during and after the curing period, shall not be used. Only approved covering shall be used for curing.

Exposed surfaces of concrete shall be maintained continuously in a damp or wet condition for at least the first 7 days after placing of concrete.

14.2 For concretes containing Portland pozzolana cement or Portland slag cement, the curing period as given in 16.1 shall be doubled. Curing by ponding shall, however, commence after the first 24 hours of concreting.

15. Field Tests

15.1 Workability

15.1.1 The concrete mix proportion so chosen, shall be such that the concrete is of adequate workability for the placing condition and can be property compacted with the means available.

15.12 The suggested ranges of values of workability of concrete measured in accordance with IS: 1199 are indicated in Table-5.

TABLE -5

Placing Conditions	Degree of Workability	Value of Workability
Concreting of shallow section with vibration	Very Low	20-10 seconds, Vee Bee time or 0.75 - 0.80, Compacting factor
Concreting of lightly reinforced sections with vibration	Low	10-5 seconds, Vee Bee time or 0.8 - 0.85, Compacting factor
Concreting of lightly reinforced sections without vibration, or Heavily reinforced sections with vibrations	Medium	5-2 seconds, Vee Bee time or 0.85 - 0.92, Compacting factor or 25-75 mm, slump for 20 mm aggregate

Concreting of heavily reinforced sections without vibrations	High	Above0.92, Compacting factor or 75-125mm, slump for 20mm* aggregate

* For smaller aggregate the values will be lower.

15.2 Work Tests

15.2.1 Over the full period of construction, the contractor shall carry out work tests of concrete at his own cost. Sampling from fresh concrete shall be taken as per IS: 1199 and cubes shall be made, cured and tested in accordance with IS: 516. The number of specimen to be tested and their criteria for acceptance shall be according to IS: 456. Frequency of work tests shall be as indicated below:

15.2.2 Frequency of Tests

15.2.2.1 Unless otherwise specified, for each grade of concrete, sets of test cube, each set consisting of three (3) twin specimens (i.e. total 6 Nos.) shall be taken. Number of sets shall generally be calculated based on the types and corresponding volumes of work as indicated hereunder unless otherwise directed by the Engineer-in-charge/Consultant

Mass Concrete Foundations : For every 100 Cu. M of concrete placed, one set but not less than one set for each pouring of concrete

Equipment and building Column foundations :For every 50 Cu. m of concrete placed one set but not less than one set for each pouring of concrete

Frame & thin walled Structural components Columns, beams, slabs etc.:For every 30 Cu. m of concrete placed one set but not less than one set for each pouring of concrete

15.2.2.2 The test cubes shall be sampled in presence of the Engineer-in-charge/Consultant/./Owner's representative, who will also sign the record of testing in an agreed format.

15.2.2.3 For testing the cube specimen contractor shall establish his own construction laboratory at site and the cost of testing of cubes shall be borne by him.

15.2.2.4 Supply of all required consumables, construction and erection materials including but not limited to gauges, welding, brazing, gasses and rods, electrodes, oxygen, acetylene, fuel, bolts, nuts and temporary support etc. shall be by contractor at no extra cost.

15.3 Standard Deviation

Standard deviation shall be calculated as given in IS: 456.

15.4 Acceptance Criteria

15.4.1 The concrete shall deemed to be accepted if it fulfills the requirements laid down in IS: 456.

15.4.2 lf the concrete does not comply with IS: 456, the structural adequacy of the parts affected shall be investigated and any consequential action as needed shall be taken up by the contractor at his own cost. Concrete of each grade shall be assessed separately. Concrete shall be assessed daily for compliance. Concrete is liable to be rejected if it is porous or honey-combed; its placing has been interrupted without providing a proper construction joint; the reinforcement has been displaced beyond the tolerances specified; or construction tolerances have not been met. However, the hardened concrete may be accepted after carrying out suitable remedial measures to the satisfaction of the Engineer-in-charge/Consultant

16. Finishing of Concrete

16.1 General

On striking the formwork, all surface defects such as bulges, ridges and honey-combing etc. observed shall be brought to the notice of the Engineer-in-charge/Consultant. The CLIENT Engineer-in-charge/Consultant may, at his discretion allow rectification by necessary chipping and packing or grouting with concrete or cement mortar. However, if honey-combing or sagging are of such extent as being undesirable, the Engineer-in-charge/ consultant may reject the work totally and his decision shall be binding. No extra payment shall be made for rectifying these defects, demolishing and reconstructing the structure. However, quantity of cement actually used for this purpose may be considered for reconciliation of materials. All burrs and uneven faces shall be rubbed smooth with the help of carborundum stone.

The surface of non-shuttered faces shall be smoothened with a wooden float to give a finish similar to that of the rubbed down shuttered faces. Concealed concrete faces shall be left as from the formwork except that honey-combed surface shall be made good as specified above. The top faces of slabs not intended to be covered shall be levelled and floated to a smooth finish to the rises or falls shown on the drawings or as directed. The floating shall not be executed to the extent of bringing excess fine materials to the surface. The top faces of slabs intended to be covered with screed, granolithic or similar finishes, shall be left with a rough finish.

17. Form Work

17.1 General

17.1.1 Forms for concrete shall be of plywood conforming to IS: 6461 or steel or as directed by the CLIENT Engineer-in-charge/Consultant and shall give smooth and even surface after removal thereof.

17.1.2 If it is desired by the Engineer-in-charge/Consultant, the Contractor shall prepare, before commencement of actual work, design and drawings for formwork and get them approved by the CLIENT Engineer-in-charge/Consultant. For details regarding design, detailing etc., reference may be made to IS: 14687.

17.2 Cleaning and Treatment of Formwork

The surfaces of forms that would come in contact with concrete shall be well treated with approved non- staining form release agents such as soft soap, oil, emulsions etc. Release agents shall be, applied so as to provide a thin uniform coating to the forms without contaminating the reinforcement.

17.3 Chamfers and Fillets

All corners and angles shall be formed with 45 degree mouldings to form chamfers or fillets on the finished concrete. The standard dimensions of chamfers and fillets, unless otherwise detailed or specified shall be 25x25mm. For heavier work chamfers or fillets shall be 50x50mm. Care shall be exercised to ensure accurate mouldings. The diagonal face of the moulding shall be planed or surfaced to the same texture as the forms to which it is attached.

17.4 Reuse of forms

Before reuse, all forms shall be thoroughly scrapped, cleaned, examined and when necessary, repaired and retreated, before resetting. Formwork shall not be reused, if declared unfit or un- serviceable by the Engineer-in-charge/Consultant.

17.5 Removal of Forms/Stripping Time

In the determination of time for removal of forms, consideration shall be given to the

location and character of the structures, the weather and other conditions including the setting and curing of the concrete and material used in the mix.

Forms and their supports shall not be removed without the approval of the Engineer-in-charge/Consultant/. Forms shall not be released until the concrete has achieved strength of at least twice the stress to which the concrete may be subjected at the time of removal. The formwork shall be removed without shock and methods of form removal likely to cause over stressing' or damage to the concrete, shall not be adopted. Supports shall be removed in such a manner as to permit the concrete to uniformly and gradually take the stresses due to its own weight.

In normal circumstances when average air temperature exceeds 15 degree Celsius during the period under consideration after pouring of concrete and where ordinary Portland cement is used, forms may generally be removed after expiry of following periods.

A	Walls, columns and vertical faces of all structural members	16 to 24 hours as may be decided by the Engineer-in-charge/Consultant.
B	Slabs (props left under)	3 days
C	Beam Soffits (props left under)	7 days
D	Removal of props under slabs:	
	Spanning upto 4.5m.	7 days
	Spanning over 4.5m	14 days
E	Removal of props under beams and arches:	
	Spanning upto 6m	14 days
	Spanning over 6m	21 days
F	Cantilever Construction	Formwork shall remain till structures for counter acting or bearing down have been erected and have attained sufficient strength (minimum 14 days).

Notes:

1. For other cements, the stripping time recommended for ordinary Portland cement shall be suitably modified as per the instructions of the Engineer- in-Charge.

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

3. Where the shape of the element is such that the formwork has re-entrant angles, the form work shall be removed as soon as possible after the concrete has set, to avoid shrinkage cracking occurring due to the restraint imposed.

4. For rapid hardening cement, 3/7 of the above mentioned periods shall be considered subject to a minimum of 16 hours.

18. Exposed / Architectural Concrete Work

18.1 Form Work

Other things remaining same as per clause 20.0, formwork shall be of high quality. Care shall be taken to arrange the forms so that the joints between forms correspond with the pattern indicated in the drawings. The forms shall be butting with each other in straight lines, the corners of the boards being truly at right angles. The joints between the forms shall cross in the two directions at right angles. The size of forms shall be so selected as to exactly match with the pattern of forms impression on the concrete face indicated in the drawings. Maximum care shall be taken to make the form work watertight. Burnt oil shall not be used for treatment of forms. The Contractor shall be permitted reuse of forms brought new on the work for exposed concrete work as specified below.

19. Reinforcement

The Contractor shall develop the bar bending schedule for all RCC structures/ structural parts at no extra cost to the Owner and shall get it reviewed by the CLIENT Engineer-in- Charge. Reinforcement shall be cut and bent to shape as per dimensions shown in the bar bending schedule/ drawings.

19.1 Straightening, Cutting and Bending

Procedure for cutting and bending shall be as given in IS: 2502. In case bars are supplied in coils, they shall be smoothly straightened without any kinks.

19.2 Placing and Fixing

All reinforcement shall be cleaned to ensure freedom from loose mill scale, loose rust, oil, form releasing agents, grease or any other harmful material before placing them in position. Reinforcement shall not be surrounded by concrete unless it is free from all such materials. Rough handling and dropping of reinforcement from a height shall be avoided

All reinforcement shall be fixed in the correct position and shall be properly supported to ensure that displacement will not occur when the concrete is placed and compacted.

The uncoated reinforcement bars shall be tied at every intersection by two strands of 16 SWG black soft annealed binding wire. Crossing bars shall not be tack welded for assembly of reinforcement.

19.3 Splicing/Overlapping

Only bars of full length shall be used as shown in the drawings. But where this cannot be done, overlapping of bars shall be done as directed by the Engineer-in- Charge. Where practicable, the overlapping bars shall not touch each other, but these shall be kept apart by 25mm or 1.25 times the maximum size of the coarse aggregate whichever is greater. But where this is not possible, the overlapping bars shall be tied with two strands of 16 SWG black soft annealed binding wire for uncoated bars GI 18 SWG wire. The overlaps shall be staggered for different bars and located at points along the span where neither shear nor bending moment is maximum.

19.4 Tolerance to Cover

The actual concrete cover shall not deviate from the required nominal cover by - 0 to + 10 mm measured over the steel reinforcement including links.

20. Damp Proof Course (DPC)

20.1 The 14 mm thick damp proof course shall consists of plain cement concrete of grade M 15 or nominal mix concrete of 1:2:4 (1 cement: 2 coarse sand : 4 stone aggregate) with 10 mm and downgraded aggregate, unless otherwise specified.

20.2 The DPC shall be laid at plinth level of brick walls, flush with the floor surface and shall not be carried across doorways.

20.3 Before lying the top surface of wall shall be thoroughly cleaned and watered. The DPC shall be laid in layers of 20 mm thickness retaining the edges by necessary formwork and shall be well tamped and trowelled to smooth finish. DPC should be kept wet for at least 3 days and after it has dried two coats of hot bitumen of grade A 90 / S 90 conforming to IS: 73 shall be applied over it at the rate of 1.7 kg / sq. m. and over this dry sand shall be sprinkled evenly.

21. Grouting

21.1 Before placing the grout, the concrete surface shall be thoroughly cleaned, preferably with compressed air and the surface shall be thoroughly wetted with water for several hours. Grouting concrete shall be of grade M20 or more unless otherwise shown in the drawing with 6 mm down stone aggregates. Before placing the grout all free water shall be removed and the
Flat surface shall be coated with thin cement
slurry.

The grout shall be carefully observed for initial settlement. If any settlement is observed, further grout is to be poured and compacted by rods.

For base plates having ribs underside the base plate, proper care is to be taken to ensure filling of the cavities between the ribs. In case of wide base plates or bed plates having ribs underside, it may be necessary to do pressure grouting as directed by the CLIENT Engineer-in-charge/Consultant.

21.2 Graving

The grout must not dry out after it is placed in position. The surface shall be kept moist with wet sacks for at least seven days.

21.3 Admixtures
If any admixtures is to be used with the grout, it shall be with prior approval of the CLIENT Engineer-in-charge/Consultant

21.3.1 Non-Shrinking Grout

Non shrinking grout where required shall be used in accordance with the methods specified by the manufacturer. Material shall be as approved by the Engineer-in-charge/ consultant.

21.3.2 The placement of grout shall be continuous so as to avoid "cold joints" under base plate and thoroughly worked under so as to eliminate air bubbles and voids. Rods or chains may be used to expedite this procedure.

Grout shall be placed so as to provide full and uniform bearing under all bearing surfaces. Where forms are used for grouting, they shall remain in place for a period of 24 hours unless directed otherwise. All exposed grout with a thickness of 25 mm or more shall be sloped at about 45 degree unless otherwise noted.

22. Clean Up

Upon the completion of concrete work, all debris, scraps of wood etc. resulting from the

work shall be removed and the premises left clean.

23. Payment

Not applicable

23.1 Plain and Reinforced Concrete

23.1.1 Payment for plain and reinforced cement concrete (cast- in-situ) shall be made on cubic metre basis of the volume of the actual finished work done or as per approved construction drawings,

whichever is less and shall be inclusive of providing pockets, openings, recesses of all sizes, chamfers, fillets, grooves, separation/ expansion/ isolation/ construction/ movement joints, cement wash, curing by normal moist curing or using curing compound etc. as directed by CLIENT Engineer-in-charge/Consultant etc. The rates shall be deemed to include complete cost of getting the respective mix designs approved, making and testing concrete cubes and carrying out other tests including tests of various ingredients, as per specifications and as directed by CLIENT Engineer-in-charge/Consultant. For tests on concrete cubes done by accelerated methods of curing as defined in IS: 9013.

23.1.2 No separate payment shall be made for any additive/ admixture used by the contractor for accelerating or retarding the strength of concrete or for achieving specified workability/water tightness. The rate quoted shall be deemed to be inclusive of all costs related to any such additive/ admixture.

23.1.3 The rate shall however be exclusive of reinforcement, metal inserts, pipe sleeves and any filler material in expansion/isolation joints.

23.1.4 Where the strength of concrete mix (nominal or design) as indicated by tests, lies in between the strengths of any two grades given in Table-1 and it is accepted by the Owner/CLIENT, Engineer-in-charge/Consultant, such concrete shall be classified as a grade belonging to the lower of the two grades between which it lies. In case the cube strength shows higher results than those specified for the particular grade of the concrete, it shall not be placed in the higher grade nor shall the Contractor be entitled for any extra payment on such account. The concrete giving lower strength than specified may be accepted at reduced rates after satisfying the safety of the structure by checking it with tests as specified or rejected entirely at the discretion of the Engineer-in- Charge. The rejected concrete shall be dismantled at no extra cost to the owner and no payment or extension of time shall be granted for the concrete so rejected and the formwork and reinforcement used for the same. Cost of any material supplied by the Owner free of cost shall be recovered from the Contractor at double the prevailing market rate. In case the concrete of lower strength can be improved by carrying out some strengthening measures entirely at the discretion of the CLIENT Engineer-in-charge/Consultant/, then the said measures including all related tests shall be carried out by Contractor at his own cost. If the Contractor is able to make up the strength to the required grade by such improvement measures to the entire satisfaction of CLIENT Engineer-in- Charge, payment shall be made for the grade achieved. However, if the strength of concrete is not made up to the strength of required grade, payment shall be made only for the lower strength if such concrete is accepted by the Engineer-in-charge/Consultant.

23.1.5 Deductions for openings, pockets etc. shall be as specified in relevant Indian Standard Codes.

23.1.6 Payment under continuous concreting item in the schedule of rates shall be made only where the total quantity of concrete between two consecutive construction joints specifically called- out on the drawings exceeds 250 cubic metres. For any foundation/structure involving concrete quantity upto 250 cubic metres between two consecutive construction joints shown on drawings, the concrete shall not be measured or paid for under this category (i.e. continuous concreting), although the same is required to be constructed in

single pour. The rate quoted against this item shall be inclusive of all extra costs incurred by the Contractor for arranging continuous pouring of concrete and others as specified complete.

23.2 Reinforcement

23.2.1 Payment for plain round mild steel reinforcement bars and high strength deformed steel bars shall be on the basis of weight of bare steel irrespective of any coating applied in metric tons. The weight of the bar shall be derived from the sizes and corresponding unit weights given in handbook of Bureau of Indian Standards. Standard hook lengths, chairs, spacer bars and authorised laps only shall be included in the weight calculated. Binding wire shall not be weighed nor otherwise measured. Measurements for weight shall not include cutting allowance etc.

23.2.2 Rate quoted for uncoated reinforcement shall include cost of supplying, decoiling, straightening, cleaning, cutting, bending, placing, binding, welding, if required, and providing necessary cover blocks of concrete.

23.2.3 Rate quoted for Fusion Bonded Epoxy Coated bars shall also include, apart from those mentioned in Cl. 27.3.2, cost of coating of the bars, all necessary tools and tackles and any repairs required due to damage to coating as per IS: 13620-1973.

23.2.4 Payment for mechanical threaded couplers shall be made on number basis (each). The rate shall include supply of complete assembly, fixing, testing etc. all complete.

23.3 Expansion/Isolation Joints

23.3.1 Payment for filler materials in Expansion/Isolation joints shall be made on running metre basis of the joint provided. For boards provided at expansion/isolation joints, the measurement shall be made on square metre basis. Rate shall be inclusive of supply, cutting, fixing, jointing, wastage etc. complete.

TECHNICAL SPECIFICATION FOR STRUCTURAL STEEL WORKS

Scope

This specification covers the requirements for material, storage, preparation of fabrication drawings, fabrication, assembly, tests/examinations, transportation, erection and painting of all types of bolted and/or welded structural steel works for general construction work. Fabrication of structures shall also include fabricating:

a) Built up sections/plate girders made out of rolled section and/or plates.

b) Compound sections made out of rolled sections.

1 Reference

1.1 BIS Codes

IS: 210	Grey Iron Casting
IS: 226	Structural Steel (Standard Quality)
IS: 451	Technical supply of wood screw
IS: 800: 2007	Code of Practice for general construction in Steel
IS: 801	Code of practice for use of cold formed light gauge steel structural members In general building construction
IS: 803	Code of practice for design, fabrication and erection to vertical mild steel Cylindrical welded storage tanks
IS: 802 : 1978 Part 2 :	Code of Practice for use of Structural Steel in Overhead Transmission Towers-Fabrication, Galvanizing, Inspection and Packing
IS: 806 : 1968	Code of Practice for USE OF Steel Tubes in General Building Construction
IS: 808 : 1989	Dimensions for Hot Rolled Steel Beam, Column, Channel and Angle Section
IS 813	Scheme of symbols for welding
IS:814 : 2004	Covered Electrodes for Manual Metal Arc Welding of Carbon and Carbon Manganese Steel Specification
IS 818	Code of practice for safety and health requirement in electric and gas Welding and cutting operations.
IS:816 : 1969	Code of Practice for use of Metal Arc Welding for General Construction in Mild Steel.
IS: 822	Code of practice for inspection of welding
IS :961	Structural Steel (High tensile)
IS : 1024	Code of practice for use of welding in bridges and structures subjects to dynamic loads
IS : 1030	Carbon steel casting for general engineering purpose
IS : 1120	Coach Screw
IS: 1149	Specification of high steel rivet, bars for structural purpose
IS:1161 : 1998	Specification For Steel Tubes for Structural Purposes.

IS:1182 : 1983	Recommended practice for radiographic examination of fusion welded butt joints in steel plates
IS : 1239	Mild steel tubes, Tubular and other wrought steel fittings Part-1 Mild steel ,Part-11,Mild steel tubular and other wrought sheet pipefittings
IS:1363	Black Hexagonal Headed Bolts, Screws, Nuts & Locknuts of Product Grade C- Hexagon Head Bolts (M5-M64) Part 1& 3: 2002
IS:1367 Part 1	Technical Supply Conditions for Threaded Steel Fastene
IS:1852 : 1985	Rolling and Cutting Tolerances for Hot Rolled Steel Products
IS : 1977	Structural steel (Ordinary quality)
IS: 2016	Plain washer
IS:2062 : 1999	Steel For General Structural Purposes-Specification
IS: 2595	Code of practice for Radiographic testing
IS:3502 : 1994	Specification For Steel Chequered Plates
IS :3600	Code of practice for testing of fusion welded (Part-1) joints and weld metal in steel
IS:3658 : 1999	Code of Practice for Liquid Penetrant Flaw Detection
IS:3757 : 1985	High Strength Friction Grip Structural Bolts
IS:4260 : 2004	Recommended Practice for Ultrasonic Testing of Butt Welds in Ferritic Steel
IS:5334 : 2003	Code of Practice for Magnetic Flaw Detection of Welds
IS:5369 : 1975	General Requirements for Plain Washers and Lock Washers.
IS:5372 : 1975	Specification-Taper washers for Channels.
IS:5374 : 1975	Specification - Taper Washers for I – Beams

IS : 5624	Specification for foundation bolt
IS:6639 : 2005	Specification for Hexagon Bolts for Steel Structures
IS:7205 : 1974	Safety Code for Erection of Structural Steel Work
IS:7215 : 1974	Tolerances for Fabrication Of Steel Structures
IS:7307 Part 1 :1974	Approval Tests for Welding Procedures Part 1- Fusion Welding of Steel
IS:7310 Part 1 : 1974	Approval Tests for Welders working to Approved Welding Procedures Part 1- Fusion Welding of Steel
IS:7318 Part 1 :1974	Approval Tests for Welders working to Approved Welding Procedures Part 1- Fusion Welding of Steel
IS:8500 : 1991	Weldable structural steel (Medium and High Strength qualities)
IS:9595 : 1996	Recommendation for metal arc welding of carbon manganese steel
IS:12843 :1989	Tolerances for Erection Of Steel Structures

2.2 In case of conflict between the clauses mentioned in this specification and those in the Indian Standards, this specification shall govern. Any special provision as shown or noted on the design drawings shall govern over the provisions of this specification

2 Materials

3.1 Structural Steel

3.1.1 All structural steel shall be of tested quality. The material of all Indian rolled section and plates shall conform to IS 2062 Grade – A designation Fe410WA specified therein.

3.1.2 Wherever the material is procured by the contractor, the contractor shall submit the test certificates conforming to the relevant Indian standards of all steel materials used for fabrication. All structural steel shall be free from blisters, rust, scales, seams, lamination, cracks, fissures and other surface defects.

3.1.3 Carbon steel pipes/tubes for structural purposes shall be as per IS: 1161 grade YST-25. In case mild steel is available according to latest IS: 2062, steel to grade A, B & C will be used as applicable.

3.2 Bolts and Nuts

Bolts and nuts shall conform to IS: 1363 or IS: 1364: 2002 as applicable and as shown in the drawing. Unless otherwise specified nuts and bolt heads shall be hexagonal. Property

class of nuts and bolts shall be compatible. The contractor shall submit test certificates when called for. Wherever shown in the drawing high strength friction grip bolts (HSFG bolts) and nuts conform to IS: 3757 and IS: 6623: 2004 respectively shall be used. Nuts shall be of at least the strength grade appropriate to the grade of bolts or other threaded elements with which they are used.

3.3 Washers

Plain washers shall be made of mild steel conforming to IS: 5369 unless noted otherwise. Minimum one washer shall be supplied for each bolt and in case of special types of bolts more than one washer as required for the purpose shall be supplied. Helical spring washer conforming to IS: 6755: 1980 shall be provided for bolts carrying dynamic or fluctuating loads and those in direct tension. Tapered washers conforming to IS: 5372 & IS: 5374 shall be used for channels & beams respectively. Washers for high strength friction bolts shall conform to IS: 6649: 1985

3.4 Welding Consumables

3.4.1 Covered electrodes (for metal arc welding of structural steel) shall conform to IS: 814 & IS:2062.

3.4.2 Filler rods & wires for gas welding shall conform to IS: 1278: 1972

3.4.3 Base wire electrodes (in submerged arc welding of structural steel) shall conform to IS: 7280:1974 The combination of wire and flux shall comply with the requirements of IS: 3613: 1974

3.4.4 Filler rods & base electrodes (for gas shield arc welding of structural steel) shall conform to IS:6419: 1996

3.4.5 Welding consumables & procedures shall be such that the mechanical properties of deposited weld metal are not less than the respective minimum values for the parent metal being welded.

3.5 Steel Gratings, Stair Treads & Chequered Plates

3.5.1 Steel grating and stair treads shall be open grid rectangular pattern complying with standard drawings.

3.5.2 Steel chequered plates shall conform to IS: 3502.

3.6 Receipt & Storing of Materials

3.6.1 Each section shall be marked for identification and each lot shall be accompanied by manufacturer's test/quality certificate, chemical analysis and mechanical characteristics.

3.6.2 All sections shall be checked, sorted out and arranged by grade and quality in the store yard. Any instruction given by the Engineer-in-charge/Consultant in this respect shall be strictly followed.

3.6.3 All material shall be free from surface defects such as pitting, cracks, laminations, twists etc.

Defective material shall not be used and all such rejected material shall be immediately

removed from the store/site. The decision of the Engineer-in-charge/Consultant in this regard shall be final and binding.

3.6.4 Welding wires and electrodes (packed in their original cartons) shall be stored separately by quality and lots inside a dry and enclosed room in compliance with IS: 9595 and as per the

Instructions given by the Engineer-in-charge/Consultant. Electrodes shall be kept perfectly dry to ensure satisfactory operation and weld metal soundness.

3.6.5 Each lot of electrodes, bolts, nuts etc. shall be accompanied by manufacturer's quality/test certificates.

3.6.6 All bolts (including nuts & washers) shall be checked, sorted out and arranged diameter-wise by grade and quality in the store.

3.7 Material Tests

3.7.1 The Contractor shall submit manufacturers' quality certificates for all the materials supplied by him. In case, quality certificates are not available or are incomplete or when material quality differs from standard specifications, such materials shall not be used in the construction. However, the Contractor shall get all appropriate tests conducted in approved test houses for such materials as directed by the Engineer-in-charge/Consultant, at no extra cost, and submit the same to Engineer-in-charge/ consultant for his approval. The CLIENT Engineer-in-charge/Consultant may approve the use of such materials entirely at his discretion.

3.7.2 The Contractor shall ensure that all materials brought to site are duly approved by the CLIENT Engineer-in-charge/Consultant. Rejected materials shall not be used and shall be removed from site forthwith. Any material of doubtful quality for which specific tests are to be carried out as per the instruction of the CLIENT Engineer-in-charge/Consultant/Consultant shall be separately stacked and properly identified and shall not be used. These shall be removed from site forthwith.

3 Fabrication Drawings

4.1 Fabrication and erection drawings shall be prepared by the Contractor on the basis of "Approved for Construction (AFC)" design drawings, INDIAN STANDARDS Standards issued to the Contractor. These drawings conforming to IS: 800 shall be prepared by the Contractor or by an agency appointed by the Contractor and approved by the Engineer-in-charge/Consultant.

4.2 Fabrication and erection drawings shall be thoroughly checked, stamped "Approved for Construction" and signed by the Contractor's own responsible Engineer irrespective of the fact that such drawings are prepared by the Contractor or his approved agency, to ensure accuracy and correctness of the drawings. Unchecked and unsigned drawings shall not be used for the purpose of proceeding with the work. The Contractor shall proceed with the fabrication and erection work only after thoroughly satisfying himself in this regard.

4.3 All fabrication and erection drawings shall be issued for construction by the Contractor directly to his work- site. Six copies of such drawings shall simultaneously be submitted to the CLIENT Engineer-in-charge/Consultant who may check/ review some or all such

drawings at his sole discretion and offer his comments for incorporation in these drawings by the Contractor.

However, the Contractor shall not proceed with the fabrication of such structures whose fabrication drawings are required to be reviewed before taking up the fabrication work as noted on "Approved for Construction (AFC)" design drawings issued to the Contractor or as conveyed by the CLIENT Engineer-in-charge/Consultant. The fabrication of such structures shall be done only as per the reviewed fabrication drawings.
The review of such drawings by INDIAN STANDARDS shall be restricted to the checking of the following only:

i) Structural layout, orientation and elevation of structures members,

ii) Sizes of members,

iii) Critical joint details.

4.4 Fabrication drawings shall be drawn to scale and shall convey the information clearly and adequately. Following information shall be furnished on such drawings:

- Reference to design drawing number (along with revision number) based on which fabrication drawing has been prepared.
- Structural layout, elevations & sections (with distinct erection marking of all members).
- Framing plans, member sizes, orientation and elevations.
- Layout and detailing of rain water pipes and gutters showing all necessary levels, connections and provisions wherever required.
- Detailing of shop/field joints, connections, splices, for required strength and erection. Location, type, size and dimensions of welds and bolts.
- Shapes and sizes of edge preparation for welding.
- Details of shop and field joints/welds.
- Bill of materials/D.O.D. Lists.
- Quality of structural steel, plates etc., welding electrodes, bolts, nuts and washers to be used.
- Erection assemblies identifying all transportable parts and sub-assemblies with special erection instructions, if required.
- Method of erection and special precautions to be taken during erection as required.
- The design of ladders, platforms, handrails, stairways & the like shall be as per standard drawings.

4.5 The Contractor shall additionally ensure accuracy of the following and shall be solely responsible for the same:

i) Provision for erection and erection

clearances. ii) Marking of members

iii) Cut length of members

iv) Matching of joints and holes.

v) Provision kept in the members for other interconnected

members. vi) Bill of materials/D.O.D. Lists.

4.6 Connections, splices and other details were not shown on the design drawings shall be suitably designed and shown on the fabrication drawings based on good engineering practice developing full member strength. Design calculations for such connections/splices shall be submitted to the CLIENT Engineer-in-charge/Consultant along with the fabrication drawings.

4.7 Any substitution or change in section shall be allowed only when prior written approval of the CLIENT Engineer-in-charge/Consultant has been obtained. Fabrication drawings shall be updated incorporating all such substitutions/changes by the Contractor at no extra cost to the Owner.

4.8 In case during execution of the work, the CLIENT Engineer-in-charge/Consultant on review of drawings considers any modifications/substitutions necessary to meet the design parameters good engineering practice, these shall be brought to the notice of the Contractor who shall incorporate the same in the drawings and works without any extra cost to the owner. The Contactor will be totally responsible for the correctness of the detailed fabrication drawings and execution of the work.

4.9 Contractor shall incorporate all the revisions made in the design drawings during the course of execution of work in his fabrication drawings, and resubmit the drawings at no extra cost to the Owner. All fabrication shall be carried out only as per the latest AFC design drawings and corresponding fabrication drawings.

4.10 The Contractor shall supply two prints each of the final/as built drawings along with their transparencies to CLIENT Engineer-in-charge/ Consultant for reference and record. The rates quoted shall include for the same.

4 Fabrication

5.1 General

5.1.1 Fabrication of structures shall be done strictly as per "Approved for Construction" fabrication drawings (prepared by the Contractor based on the latest design drawings) and in accordance with IS: 800, 9595 & other relevant BIS Codes and BIS Hand Book SP: 6(1).

5.1.2 Prior to commencement of structural fabrication, undulations in the fabrication yard, if any, shall be removed and area leveled and paved by the Contractor.

5.1.3 Any defective material used in the work shall be replaced by the Contractor at his own expense.

Necessary care and precautions shall be taken so as not to cause any damage to the structure during any such removal and replacement.

5.1.4 Any faulty fabrication pointed out at any stage of work by the Engineer-in-Charge, shall be made good or replaced by the Contractor at his own cost.

5.1.5 Tolerances for fabrication of steel structures shall be as per IS: 7215.

5.2 Fabrication Procedure

5.2.1 Straightening & Bending

5.2.1.1 All materials shall be straight and if necessary, before being worked shall be straightened and/or flattened (unless required to be of curvilinear form) and shall be free from twists.

5.2.1.2 Bending of rolled sections and plates shall be done by cold process to shape/s as shown on drawings.

5.2.2 Clearances

The erection clearance for cleated ends of members shall be not greater than 2mm at each end. The erection clearance at ends of beams without web cleats and end plates shall be not more than 3mm at each end but where for practical reasons, greater clearance is necessary, suitably designed seatings approved by the CLIENT Engineer-in-charge/Consultant shall be provided.

5.2.3 Cutting

5.2.3.1 Prior to cutting, all members shall be properly marked showing the requisite cut length/width,

connection provisions e.g. location and dimensions of holes, welds, cleats etc. Marking for cutting shall be done judiciously so as to avoid wastages or unnecessary joints as far as practicable. Marking shall be done by placing the members on horizontal supports/pads in order to ensure accuracy. Marking accuracy shall be limited to + 1mm.

5.2.3.2 Cutting may be affected by shearing, cropping or sawing. Gas cutting by mechanically controlled torch shall be permitted for mild steel. Hand flame cutting may be permitted subject to the approval of the Engineer-in-charge/Consultant.

5.2.3.3 Except where the material is subsequently joined by welding, no loads shall be transmitted into metal through a gas cut surface.

5.2.3.4 Shearing, cropping and gas cutting shall be clean, square, free from any distortion & burrs, and should the CLIENT Engineer-in-charge/Consultant find it necessary, the edges shall be ground afterwards, to make the same straight and uniform at no extra cost to the Owner.

5.2.4 Holing

5.2.4.1 Holes for bolts shall not be formed by gas cutting process.

5.2.4.2 Holes through more than one thickness of material of members such as compound stanchions and girder flanges shall, where possible, be drilled after the members are assembled and tightly clamped/bolted together. Punching may be permitted before assembly, provided the thickness of metal is less than 16 mm and the holes are punched 3 mm less in diameter than the required size and reamed, after assembly, to the full diameter. Punching shall not be adopted for dynamically loaded structures.

5.2.4.3 Holes may be drilled in one operation through two or more separable parts and burrs removed from each part after drilling.

5.2.4.4 Holes in connecting angles and plates, other than splices, also in roof members and light framing, may be punched full size through material not over 12 mm thick, except where required for close tolerance bolts or barrel bolts.

5.2.4.5 All matching holes for black bolts shall register with each other so that a gauge of 2 mm less in diameter than the diameter of hole shall pass freely through the assembled members in the direction at right angle to such members. Finished holes shall be not more than 2 mm in diameter larger than the diameter of the black bolt passing through them, unless otherwise specified by the Engineer-in-charge */consultant.*

5.2.4.6 H o l e s for turned and fitted bolts shall be drilled to a diameter equal to the nominal diameter of the shank or barrel subject to H8 tolerance specified in IS: 9I9. Parts to be connected with close tolerance or barrel bolts shall be firmly held together by tacking bolts or clamps and the holes drilled through all the thicknesses in one operation and subsequently reamed to size. Holes not drilled through all the thicknesses in one operation shall be drilled to a smaller size and reamed out after assembly. Where this is not possible, the parts shall be drilled and reamed separately.

5.2.4.7 To facilitate grouting, holes shall be provided in column bases or seating plates exceeding 300mm in width for the escape of air.

5.2.4.8 To avoid accumulation of water in gusseted column bases of laced, battened or box type stanchions, suitable reverse U-type holes shall be provided at the junction of base plate and column section in the vertical gussets for draining out of any water.

5.2.5 Assembly

The component parts shall be assembled and aligned in such a manner that they are neither twisted nor otherwise damaged, and shall be so prepared that the required camber, if any, is provided. Proper clamps, clips, jigs and other fasteners (bolts and welds) shall be placed in a balanced pattern to avoid any distortion in the members and to ensure their correct positioning (i.e. angles, axes, nodes etc.). Any force fitting, pulling/stretching of members to join them shall be avoided. Proper care shall be taken for welding shrinkage & distortion so as to attain the finished dimensions of the structure shown on the drawings.

5.2.6 Welding

5.2.6.1 General

a) All joints shall be welded unless noted otherwise on the design drawings.

b) Welding shall be in accordance with IS: 816, IS: 819: 1957, IS: 1024: 1999, IS: 1261: 1959, IS: 1323: 1982 and IS: 9595 as appropriate.

c) The Contractor shall make necessary arrangement for providing sufficient number of welding sets of the required capacity, all consumables, cutting and grinding equipment with requisite accessories/ auxiliaries, equipment & materials required for carrying out various tests such as dye penetration, magnetic particle, ultrasonic etc.

d) Adequate protection against rain, dust, snow & strong winds shall be provided to the welding personnel and the structural members during welding operation. In the absence of such a protection no welding shall be carried out. It shall be the responsibility of the Contractor to ensure that all welding is carried out in accordance with the terms of this specification and relevant BIS codes. The Contractor shall provide all the supervision to fulfill this requirement.

5.2.6.2 Preparation of Member for Welding

a) Edge Preparation

Edge preparation/beveling of fusion faces for welding shall be done strictly as per the dimensions shown in the drawings. In case, the same are not indicated, edges shall be prepared (depending on the type of weld indicated in the drawing) as per the details given in IS: 9595. Beveling of fusion faces shall be got checked and approved by the Engineer -in-charge/Consultant. The tolerances on limits of gap, root face & included angle shall be as stipulated in IS: 9595.

b) Cleaning

Welding edges and the adjacent areas of the members (extending up to 20mm) shall be thoroughly cleaned of all oil, grease, scale and rust and made completely dry. Gaps between the members to be welded shall be kept free from all foreign matter.

c) Preheating

Preheating of members shall be carried out as per IS: 9595 when the base metal temperature is below the requisite temperature for the welding process being used. Preheating shall be done in such a manner that the parts, on which the weld metal is being deposited, are above the specified minimum temperature for a distance of not less than 75mm on each side of the weld line. The temperature shall be measured on the face opposite to that being heated. However, when there is access to only one face, the heat source shall be removed to allow for temperature equalization (1 minute for each 25mm of plate thickness) before measuring the temperature.

d) Grinding

i. Column splices & butt joints of struts and compression members (depending on contact for load transmission) shall be accurately ground and close-butted over the whole section with a tolerance not exceeding 0.2mm locally at any place. In column caps & bases the ends of shafts together with the attached gussets, angles, channels etc., shall be accurately ground so that the parts connected butt over minimum 90% surface of contact. In case of connecting angles or channels, care shall be taken so that these are fixed with such accuracy that they are not reduced in thickness by grinding by more than 2 mm.

ii. Ends of all bearing stiffeners shall be ground to fit tightly at both top and bottom.

Similarly bottom of the knife edge supports along with the top surface of column brackets shall be accurately ground to provide effective bearing with a tolerance not exceeding 0.2 mm locally at any place.

iii. Slab bases and caps shall be accurately ground over the bearing surfaces and shall have effective contact with the ends of stanchions. Bearing faces which are to be grouted direct to foundations need not be ground if such faces are true & parallel to the upper faces.

5.2.6.3 Welding Processes

Welding of various materials under this specification shall be carried out using one or more of the following processes.

- Manual Metal Arc Welding Process (MMAW)
- Submerge Arc Welding Process (SAW)
- Gas Metal Arc Welding Process (GMAW)
- Flux Cored Arc Welding Process (FCAW)

The welding procedure adopted and consumables used shall be specifically approved by the Engineer-in-charge/Consultant. A combination of different welding processes or a combination of electrodes of different classes/makes may be employed for a particular joint only after qualifying the welding procedures to be adopted and obtaining the written approval of the Engineer-in-charge/Consultant. Welding procedure shall cover the following:

i) Type and size of electrodes ii) Position of welding

iii) Current and arc voltage

iv) Length of run per electrode or (for automatic welding) speed of travel of electrode

v) Number of run in multipass welds and arrangement

vi) Preparation of the parts

vii) Welding sequence

viii) Pre or post heating

5.2.6.4 Approval & Testing of Welders

The Contractor shall satisfy the Engineer-in-charge/Consultant that the welders are suitable for the work upon which they will be employed. For this purpose the welders shall have satisfied the relevant requirements of IS: 7318. If the welders will be working to approved welding procedures, they shall have satisfied the relevant requirements of 1S: 7310.

Adequate means of identification shall be provided to enable each weld to be traced

to the welder by whom it was made. The Contractor shall intimate the INDIAN STANDARDS Engineer-in-charge/Consultant sufficiently in advance, the commencement of tests, to enable him to be present to witness the same.

5.2.6.5 Approval & Testing of Welding Procedures

The Contractor shall carry out procedure tests in accordance with IS: 7307 to demonstrate by means of a specimen weld of adequate length on steel representative of that to be used, that he can make welds with the welding procedure to be used for the work to the complete satisfaction of the Engineer-in-charge/Consultant. The test weld shall include weld details from the actual construction and it shall be welded in a manner simulating the most unfavorable instances of fit-up, electrode condition etc., which are anticipated to occur on the particular fabrication. Where material analysis is available, the welding procedure shall be carried out on material with the highest carbon equivalent values.

After welding, but before the relevant tests given in IS: 7307 are carried out, the test weld shall be held as long as possible at room temperature, but in any case not less than 72 hours, and shall then be examined for cracking. The examination procedure shall be sufficiently rigorous to be capable of revealing significant defects in both parent metal and weld metal.

After establishing the welding method, the Contractor shall finally submit to the INDIAN STANDARDS Engineer-in-charge/Consultant for his approval The welding procedure specification in standard format given in IS: 9595 before starting the fabrication.

5.2.6.6 Sequence of Welding

a) As far as practicable, all welds shall be made in a sequence that will balance the applied heat of welding while the welding progresses.

b) The direction of the general progression in welding on a member shall be from points where the parts are relatively fixed in position with respect to each other towards points where they have a greater relative freedom of movement.

c) All splices in each component part of a cover-plated beam or built up member shall be made before the component part is welded to other component parts of the member.

d) Joints expected to have significant shrinkage shall be welded before joints expected to have lesser shrinkage.

e) Welding shall be carried continuously to completion with correct number of runs.

f) The Contractor shall choose the welding sequence after carefully studying each case such as to minimize distortion and shrinkage & submit the same to the Engineer-in-Charge for comments and approval.

g) The welding seams shall be left to cool slowly. The CONTRACTOR shall not be

allowed t o cool the welds quickly by any other method.

h) For multipass welding, before welding the following layer the formerly welded layer shall be cleaned metal bright by light and wire brushing.

5.2.6.7 Welding Technique

a) After the fusion faces are carefully aligned and set with proper gaps, the root pass of butt joints shall be executed properly so as to achieve full penetration with complete fusion of the root edges.

b) On completion of each run all slag and spatters shall be removed and the weld and the adjacent base metal shall be cleaned by wire brushing and light chipping. Visible defects such are cracks, cavities and other deposition faults, if any, shall be removed to sound metal before depositing subsequent run of weld.

c) All full penetration butt welds shall be completed by chipping/gouging to sound metal and then depositing a sealing run of weld metal on the back of the joints. Where butt welding is practicable from one side only, suitable backing steel strip shall be used and joint shall be arranged in such a way as to ensure that complete fusion of all the parts is readily obtained.

d) While welding is in progress care shall be taken to avoid any kind of movement of the components, shocks, vibrations to prevent occurrence of weld cracks.

e) Any deviation desired from the recommended welding technique and electrodes shall be adopted only after obtaining written approval of the Engineer-in-charge/Consultant

5.2.6.8 Inspection & Testing of Welds

The method of inspection shall be according to IS: 822: 1970 and extent of inspection and testing shall be in accordance with the relevant applicable standard or, in the absence of such a standard, as specified by the Engineer-in-charge/Consultant/Consultant/consultant. Welds shall not be painted or otherwise obscured until they have been inspected, approved and accepted.

The CLIENT Engineer-in-charge/Consultant or his representative shall have access to the Contractor's work at all reasonable times and the Contractor shall provide him with all facilities necessary for inspection during all stages of fabrication and erection with, but not limited to, the following objectives.

i) To check the conformity with the relevant standards and suitability of various welding equipments and their performance.

ii) To witness/approve the welding procedure qualification.

iii) To witness/approve the welders performance qualification.

iv) To check whether shop/field welding being executed is in conformity with the

relevant specifications and codes of practice.

Inspection and testing of all fabricated structures shall be carried out by the Contractor by any, or, a combination of all the following methods as directed by the Engineer-in-Charge and no separate payment shall be made, unless otherwise mentioned, for inspection and testing of welds/fabricated structures:

A. Visual Inspection

a. All finished welds (i.e. 100 percent) shall be visually inspected for identification of the following types of weld defects & faults.

b. Weld defects occurring at the surface such as blow holes, exposed porosity, unfused welds etc.

c. Surface cracks in the weld metal or in the parent metal adjacent to it.

d. Damages to the parent metal such as undercuts, burning, overheating etc.

e. Profile defects such as excessive convexity or concavity, overlapping, unequal leg lengths, excessive reinforcement, incompletely filled grooves, excessive penetration beads, root grooves etc.

f. Distortion due to welding i.e., local shrinkage, camber, bowing, twisting, rotation, Warines
s etc.

g. Linear eccentric, angular and rotational misalignment of

parts. h. Dimensional errors.

B. Mechanical Tests

The mechanical testing (such as tensile load tests, bend tests, impact tests etc.) shall be done in accordance with the relevant standards and as per the instructions of the Engineer-in-charge/Consultant.

C. Magnetic Particle/Dye Penetration/Ultrasonic Examination:

The examination shall be done at random as directed by the Engineer-in- Charge. Whenever such tests are directed, the tests shall be carried out on joints chosen by him. The tests shall be carried out by employing approved testing procedure in accordance with IS: 822.

D. Radiographic Examination

Radiographic examination shall be carried out for joints as directed by the Engineer-in-charge/ consultant. The Contractor shall be noting extra paid for such examinations the cost of examination shall be borne by Contractor. The Contractor shall make necessary arrangement at his own expense for providing the radiographic equipment, films and all other necessary materials required for carrying out the examination. The tests shall be carried in the presence of the Engineer-in- Charge by employing approved testing procedure in accordance with IS: 822. The Contractor shall fulfill all the statutory safety requirements while handling X-ray and Gamma-ray equipment and provide the Engineer- in-Charge/Consultant all the necessary facilities at site such as dark room, film viewer etc., to enable him to examine the

radiographs.

5.2.6.9 Repair of Faulty Welds

No repair of defective welds shall be carried out without proper permission of the Engineer-in-charge/Consultant and his approval for the corrective procedure.

Welds not complying with the acceptance requirements (as specified by BIS Codes &the Engineer-in-charge/ consultant), as revealed during inspection & testing of welds or erection or in-situ condition shall be corrected either by removing & replacing or as follows:

a) Excessive convexity — Reduced to size by removal of excess weld metal.

b) Shrinkage cracks, cracks in parent plates and craters — Defective portions removed down to sound metal and rewelded

c) Under cutting. — Additional weld metal deposited.

d) Improperly fitted/ misaligned parts. — Welding cut & edges suitably prepared and parts.

e) Members distorted by heat of Welding — Member straightened by mechanical means or careful application of limited amount of heat.

f) Temperature of such area shall be less than 650 degree Centigrade (dull red heat).

In removing defective parts of a weld, gouging, chipping, oxygen cutting or grinding shall not extend into the parent metal to any substantial amount beyond the depth of weld penetration,unless cracks or other defects exist in the parent metal. The weld or parent metal shall not be undercut in chipping, grinding, gouging or oxygen cutting.

Any fabricated structure or its component which in the opinion ofCLIENT Engineer-in-Charge is defective and/or beyond any corrective action shall be removed forthwith from the site as instructed by the Engineer-in-charge/consultant without any extra claim. The owner reserves the right to recover any compensation due to any loss arising out of such rejections.

5.2.7 Bolting

5.2.7.1 All bolts shall be provided such that no part of the threaded portion of the bolts is within the thickness of the parts bolted together. Washers of suitable thickness shall be used under the nuts to avoid any threaded portion of the bolt being within the thickness of parts bolted together.

5.2.7.2 The threaded portion of each bolt shall project through the nut at least one thread.

5.2.7.3 Flat washers shall be circular and of suitable thickness. However, where bolt heads/nuts bear upon the beveled surfaces, they shall be provided with square tapered washers of suitable thickness to afford a seating square with the axis of the bolt.

5.2.8 Splicing

5.2.8.1 Splicing of built up/compound/latticed sections shall be done in such a fashion that each component of the section is joined in a staggered manner.

5.2.8.2 Where no butt weld is used for splicing, the meeting ends of two pieces of joist/channel/built up section shall be ground flush for bearing on each other and suitable flange and web splice plates shall be designed and provided for the full strength of the flange/ web of the section and welds designed accordingly.

5.2.8.3 Where full strength butt weld is used for splicing (after proper edge preparation of the web and flange plates) of members fabricated out of joist/ channel/ angles/ built up section, additional flange and web plates shall be provided, over and above the full strength butt welds, to have 40% strength of the flange and web.

5.2.8.4 Where a cover plate is used over a joist/channel section the splicing of the cover plate and channel/joist sections shall be staggered by minimum 500mm. Extra splice plate shall be used for the cover plate and joist/channel section as per clause 5.2.8.2 or 5.2.8.3.

5.2.8.5 Prior approval shall be obtained by the Contractor for locations of splices where not shown on design drawings. Only a single splice at approved location shall be allowed for members up to a length of 6 to 7m. Maximum two numbers of splices shall be allowed for members exceeding this length.

5.2.9 Machining & Grinding

5.2.9.1 All slab bases and slab caps shall be accurately machined over the bearing surfaces and shall be in effective contact with the ends of column sections (shafts).

5.2.9.2 For slab bases and slab caps, ends of column shafts shall be accurately machined. However, for gusseted bases and caps, the column shafts shall be ground flush for effective contact with parts connected together.

5.2.9.3 Gusseted bases and caps shall be ground flush for effective contact with ends of column sections.

5.2.9.4 End of all bearing stiffeners shall be machined or ground to fit tightly at top and bottom without any air gap.

5.2.9.5 While machining or grinding care shall be taken so that the length or thickness of any part does

Not get reduced by more than 2.0 mm.

5.2.9.6 For all machining or grinding works for gusseted base and cap plates, the clearance between the parts joined shall not exceed 0.2 mm at any location.

5 Marking for Identification

6.1. Each component shall be distinctly marked (with paint) before delivery in accordance with the marking diagrams and shall bear such other marks as will facilitate erection.

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

6 Shop Erection

The steel work shall be temporarily shop erected complete or as directed by the Engineer-in-charge/Consultant, so that the accuracy of fit may be checked before dispatch.

7 Inspection & Testing of Structures

8.1 The CLIENT Engineer-in-charge/Consultant (or his authorized representative) shall have free access at all times to those parts of the Contractor's works which are concerned with the fabrication of the steel work and shall be provided with all reasonable facilities for satisfying himself that the fabrication is being undertaken in accordance with the provisions of these specifications & other relevant BIS Codes.

8.2 Should any structure or part of a structure be found not to comply with any of the provisions of this specification (or relevant BIS Codes as referred to), it shall be liable to rejection. No structure or part of the structure, once rejected shall be resubmitted for inspection, exception cases where the Engineer-in-charge/Consultant/ or his authorized representative considers the defect as rectifiable.

8.3 Defects which may appear during/after fabrication/ erection shall be made good only with the consent of the Engineer-in-charge/Consultant and procedure laid down by him.

8.4 All necessary gauges and templates shall be supplied free to the Engineer-in-Charge /Consltant by the Contractor whenever asked for during inspection.the Engineer-in-Charge/consultant may at his discretion, check the test results obtained at the Contractor's works by independent tests at a test house, and the cost of such tests shall be borne by the Contractor.

8 Shop Painting

9.1 All components and members of steel work shall be given one shop coat of fire retardant primer (conforming toASTM-119/ISO :834) or any other primer as specified and approved, in the tender, immediately after the surfaces have been properly prepared (i.e. degreased, derusted, descaled & cleaned) in accordance with IS: 1477: 1971. The primer coat shall be applied over completely dry surfaces (using brushes of good quality) in a manner so as to ensure a continuous and uniform film without "holidaying". Special care shall be taken to cover all the crevices, corners, edges etc. However, in areas which are difficult to reach by brushing, daubers/mops shall be used by dipping the same in paint and then pulling/ pushing them through the narrow spaces. The primer coat shall be air dried and shall have a minimum film thickness of 25 microns or (tolerance + 10%) after drying, as applicable.

9.2 Surfaces which are inaccessible after shop assembly, shall receive the full specified protective treatment before assembly

9.3 Steel surfaces shall not be painted within a suitable distance of any edges to be welded if the paint specified would be harmful to welders or impair the quality of the welds.

9.4 Welds and adjacent parent metal shall not be painted prior to deslagging, inspection and approval by the Engineer-in-charge/Consultant.

9.5 Parts to be encased in concrete shall have only one coat of primer and shall not be painted after erection.

9 Packing

10.1 All items shall be suitably packed in case these are to be dispatched from the fabrication shop to the actual site of erection so as to protect them from any damage/distortion or falling during transit. Where necessary, slender projecting parts shall be temporarily braced to avoid warping during transportation.

10.2 Small parts such as gussets, cleats etc., shall be securely wired on to their respective main members.

10.3 Bolts, nuts washers etc. shall be packed in crates.

10 Transportation

Loading and transportation shall be done in compliance with transportation rules. In case, certain parts cannot be transported in the lengths stipulated on the drawings, the position details of such additional splice joints shall be got approved by the Engineer-in-Charge.

11 Site (Field) Erection

12.1 Plant & Equipment

The suitability and capacity of all plant and equipment used shall be to the complete satisfaction of the Engineer Engineer-in-charge/Consultant.

12.2 Storing & Handling

All steel work shall be so stored and handled at site so that the members are not subjected to excessive stresses and any damage.

12.3 Setting Out

One set of reference axes and one bench mark level shall be furnished to the Contractor. These shall be used for setting out of structures.

The Contractor shall assume complete responsibility for correct setting out of all steel work, erecting it correctly as per alignment / levels shown in the drawings and plumb (verticality) of vertical members.

12.4 Tolerances

Tolerances for erection of steel structures shall be allow 3 to 4 mm only or as per Annexure 'A'

12 Safety & Security during Erection

13.1 The contractor shall comply with IS: 7205 for necessary safety and adhere to safe erection practices and guard against hazardous as well as unsafe working conditions during all stages of erection.

13.2 During erection, the steel work shall be securely bolted or otherwise fastened and

when necessary, temporarily braced/guyed to provide for all loads to be carried by the structure during erection till the completion, including those due to the wind, erection equipment & its operation etc. at no extra cost to the owner. For the purpose of guying, the Contractor shall not use other structure in the vicinity without prior written permission of the Engineer-in- Charge.

13.3 No permanent bolting or welding shall be done until proper alignment has been achieved.

13.4 Proper access, platform and safety arrangement shall be provided for working and inspection, (at no extra cost to the owner) whenever required.

13 Field Connections

14.1 Field Bolting

Field bolting shall be carried out with the same care as required for shop bolting.

14.2 Field Welding

All field assembly and welding shall be executed in accordance with the requirements for shop assembly and welding. Holes made for all erection bolts- where removed after final erection shall be plugged by welding. Alternatively erection bolts may be left and secured.

14 Scheme and Sequence of Erection

The Contractor shall furnish the detailed scheme and sequence of erection to match with the project schedule and get the same approved by the Engineer-in-charge/Consultant. All necessary coordination and synchronization shall be done with the civil contractor where civil works are not included in the scope of structural contractor at no extra cost so as to match with the project schedule.

15 Payment

This clause shall apply to Item Rate tender only.

16.1 Payment for structural steel works shall be made on the basis of admissible weight in metric tons (determined as described in clause 17.2 and 17.3) of the structure accepted by the Engineer-in-charge/Consultant/. The rate shall include supplying (as per supply conditions given in the Tender) fabricating, erecting in position (at all levels & locations), testing/examining (excluding radiography only) of bolted and/or welded structural steel works of all types (including all built up/compound sections made out of rolled sections and/or plates) including all handling, transporting, storing, straightening if required, cutting, edge preparation, preheating, bolting and welding of joints (including sealing the joints of box sections with continuous welding), finishing edges by grinding/machining as shown, fixing in line & level with temporary staging & bracing and removal of the same after erection, grouting with non-shrink/ordinary grout as specified, preparation of fabrication & erection drawings, erection schedule and getting them reviewed, preparation and submission of as built drawings, as built drawings, preparing the surfaces for painting, surface cleaning, wire brushing, removal of mill scale, dust, rust, oil or grease and applying one coat of red oxide zinc chromate primer or any other primer as specified after fabrication, return of surplus materials to owner's stores

and material reconciliation in the case of materials supplied by the owner as per relevant contract conditions etc. all complete for all the operations mentioned in the foregoing clauses.

16.2 The weight for payment shall be determined from the fabrication drawings and respective bill of materials prepared by the Contractor. The bill of materials shall be checked and approved by the Engineer-in-charge/Consultant/ before making the payment. The Contractor shall prepare full scale template in order to supplement/verify the actual cutting dimensions where so directed by the Engineer-in-charge/Consultant. The weight shall be calculated on the basis of BIS Code/Hand Book wherever applicable. In case sections used are different from BIS sections, then Manufacturers' Hand Book shall be adopted. No allowance in weight shall be made for rolling tolerances.

16.3 Welds, bolts, nuts, washers, shims, pack plates, wedges, grout and shop painting shall not be separately measured. The quoted rate shall be deemed to include the same.

16.4 The rate shall include all expenses related to safety & security arrangements during erection and all plants & tools required for fabrication, transportation & erection.

16 Painting after Erection

17.1 General

17.1.1 The scope of painting after erection shall be at the sole discretion of the CLIENT Engineer-in-charge/Consultant and the Contractor shall obtain written instruction in this regard sufficiently prior to taking up any procurement of paint and execution of painting work after erection of steel structures.

17.1.2 The Contractor shall carry out the painting work in all respects with the best quality of approved materials (conforming to relevant BIS Codes) and workmanship in accordance with the best engineering practice. The Contractor shall furnish characteristics of paints (to be used) indicating the suitability for the required service conditions. The paint manufacturer's instructions supplemented by CLIENT Engineer-in-charge/Consultant direction if any shall be followed at all times. Particular attention shall be paid to the following:

- Proper storage to avoid exposure & extremes of temperature,
- Surface preparation prior to painting.
- Mixing & thinning.
- Application of paint and the recommended limit on time intervals between consecutive coats.

17.1.3 Painting shall not be done in frost or foggy weather, or when humidity is such as to cause condensation on the surfaces to be painted.

17.1.4 Surface which shall be inaccessible after site assembly shall receive the full specified protective treatment before assembly.

17.1.5 Primers & finish coat paints shall be from the same manufacturer in order to ensure compatibility. Painting colour code shall be as per Annexure-'B'.

17.2 Rub Down & Primer Application

The shop coated surfaces shall be rubbed down thoroughly with emery/abrasive paper to remove dust, rust, other foreign matters and degreased, if required, in accordance with IS: 1477, cleaned with warm fresh water and air dried. The portions, from where the shop coat has peeled off, shall be touched up and allowed to dry.

Primer coat of fire retardant primer (conforming to ASTM 119/ISO:834), shall be applied by brushing/ spraying over the shop coat in a manner so as to ensure a continuous and uniform
film throughout. Special care shall be taken to cover all the crevices, corners, edges etc. The final primer coat shall be air dried and shall have a minimum film thickness of 25 microns after drying, as applicable.

In case a different cleaning procedure & primer specifications are specified in the drawing/Tender, the same shall be adopted.

17.3 Final Paint Application

After the primer is hard dry, the surfaces shall be dusted off and one coat of fire retardant paint of approved colour & shade (conforming toASTM-119/ISO-834) as specified by Engineer in Charge, shall be applied by brushing/spraying so that a film free from "holidaying" is obtained. The colour & shade of first coat of paint shall be slightly lighter than the second coat in order to identify the application of each coat. The second coat of paint shall be applied after the first coat is hard dry. The minimum thickness of each film shall be 40 microns (+ 10% tolerance) after drying.In case a different type of paint & painting procedure are specified in the drawing tender, the same shall be adopted.

Minimum time gap of 8 hours should be maintained between consecutive coatings.

17.4 Inspection & Testing of Painting Works

17.4.1 All painting materials including primers & thinners brought to site by the Contractor for application shall be procured directly from reputed and approved manufacturers and shall be accompanied by manufacturer's test certificates. Paint formulations without certificates shall not be accepted.

17.4.2 The Engineer-in-charge/Consultant at his discretion may call for additional tests for paint formulations. The Contractor shall arrange to have such tests performance including batch wise test of wet paints for physical & chemical analysis. All costs shall be borne by the Contractor.

17.4.3 The painting work shall be subject to inspection by the Engineer-in-charge/Consultant at all times. In particular, the stage inspection will be performed and Contractor shall offer the work for inspection and approval at every stage before proceeding with the next stage. The record of inspection shall be maintained. Stages of inspection are as follows:

- Surface preparation
- Primer application
- Each coat of

paint

17.4.4 Any defect noticed during the various stages of inspection shall be rectified by the Contractor to the entire satisfaction of the Engineer-in-charge/Consultant before proceeding further. Irrespective of the inspection, repair and approval at intermediate stages of work the Contractor shall be responsible for making good any defects found during final inspection/guarantee period/defect liability period, as defined in General Conditions of Contract. Dry film thickness (DFT) shall be checked and recorded after application of each coat. The thickness shall be measured at as many locations as decided by the Engineer-in-charge/Consultant The Contractor shall provide standard thickness measuring instrument such as Elko meter (with appropriate range for measuring dry film thickness of each coat) free of cost to the Engineer-in-charge/Consultant whenever asked for.

17.5 Payment

Payment for painting of structural steel works shall be made on the basis of admissible weight in metric tons of the painted structures accepted by the Engineer-in-charge/Consultant.

The rate shall include supplying & applying two coats of synthetic enamel paint or any other paint specified in the tender of approved quality and shade over a coat of red oxide zinc chromate primer or any other primer specified in the tender over one coat of shop primer already applied to structural steel works of all types/shapes at all levels, locations & positions including storage, surface preparation, degreasing, cleaning, drying, touching up of shop primer coat, providing temporary staging, testing etc. all complete to the entire satisfaction of the Engineer-in-charge/Consultant.

Annexure A: (Clause 12.4) Maximum Permissible Erection Tolerances

A. Columns

1. Deviation of column axes at foundation top level with respect to true axes.

i) In longitudinal direction

±5mm ii) In lateral direction

±5mm

2. Deviation in the level of bearing surface of columns at foundation top with respect to true level

±5 mm

3. Out of plumb (Verticality) of column axis from true vertical axis, as measured at top:

i) Up to and including 30m height ±H/1000 or ±25 mm Whichever is less

ii) Over 30m height ±H/1200 or +35 mm Whichever is less.

4.	Deviation in straightness in longitudinal & transverse planes of column throughout the height. Whichever is less.	±H/1500 or ±10 mm
5.	Difference in the erected positions of adjacent pairs of columns along length or across width of building prior to	

Annexure B: (Clause 18.1) Painting Colour Code for Structural Steel

1.	BUILDING STRUCTURAL STEEL COLUMNS. BRACKETS, BEAMS, BRACINGS, ROOF TRUSS, PURLINS, SIDEGIRTS, LOUVERS, STRINGERS	DARK GREY	ADMIRALITY
2.	PIPE RACK STRUCTURE & TRESTLE	BLACK	
3.	CHEQUERED PLATE (BOTH FACES)	BLACK	
4.	GRATING	BLACK	
5.	LADDER	RUNGS - BLACK VERTICALS & CAGE RED	
6.	HAND RAILING		
	HANDRAIL, MIDDLE RAIL, TOE PLATE	SIGNAL RED	
	VERTICAL POST	BLACK	

Circular for structure and steel work

In suppression to the circular No. D/EE (P)-1/CLIENT/2013-14/83 dated 16.5.13 and D-307/EE (P)-III/07 dated 26.09.07, the condition of procurement of cement and steel is amended as follows:

Special conditions for steel reinforcement bars:

1 (a) The CPWD/Contractor shall procure is marked TMT bars of various grades from the steel manufacturers or their authorized dealers (as per following selection criteria) having valid BIS licence for IS: 1786-2008(Amendment -1November 2012)

The procured steel should have following qualities:

I. Excellent ductility, bend ability and elongation of finished product due to possible refining technology.
II. Consumption of steel should be accurate as per design.
III. Steel should have no brittleness problem in finished product.
IV. Steel should carry the quality of corrosion and earthquake resistance.
V. Quality steel with achievement of proper level of sulphur and phosphorus as per IS:1786-2008.

(b) Selection Criteria of steel manufacturers

The supply of reinforcement steel for all CPWD works should I have following selection criteria of steel manufacturers:

Steel producers of any capacity using iron ore/ processed iron ore as the basic raw material adopting advanced Refining technologies as given hereunder,

1) DRI-EAF=Direct Reduced iron-Electric arc furnace.
2) BF-BOF=Blast furnace- Basic oxygen furnace
3) COREX-BOF=COREX-Basic oxygen furnace.

For production of liquid steel to finish product at single/ multiple locations with NABL or any other similarity placed accrediting Government body which operates in accordance with ISO/IEC17011 and accredits labs as per ISO/IEC 17025 conforming to IS:1786-2008(Amendment-1 November2012). The check list for incorporation any quality steel producer is enclosed for technical assessment is given in Annexure-I.

Chief Engineer/CPM/PM shall approve the steel manufactures for projects under their jurisdiction. NIT approving authority shall specify the manufacturers in the tender document.

(2) The contactor shall have to obtain and furnish test certificates to the Engineer-in-charge in respect of all supplies of steel brought by him to the site of work

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

(4)The steel reinforcement bars shall be brought to the site in bulk supply of 10 tonnes or more, or as decided by the Engineer-in – charge.

(5)The steel reinforcement bars shall be stored by the contractor at site of work in such a way as to prevent their distortion and corrosion, and nothing extra shall be paid on this account. Bars of different sizes and lengths shall be stored separately to facllitate easy counting and checking.

(6)For checking nominal mass, tensile strength, bend test , rebend test etc. specimens of sufficient length shall be cut from each size of the bar at random,and at frequency not less than that specified below:

Size of bar	For consignment below 100tonnes	For consignment above 100 tonnes

Under10 mm bars	One sample for each25 tonnes or part thereof	One sample for each 40 tonnes or part there of
10mm to 16 mm dia bars	One sample for each 35 tonnes or part thereof	One sample for each 40 tonnes or part there of
Over 16 mm dia bars	One sample for each 45 tonnes or part thereof	One sample for each 60 tonnes or part there of

The contractor shall supply free of charge the steel required for testing including its transportation to testing laboratories. The cost of tests shall be borne by the contractor.

(8) The actual issue and consumption of steel on work shall be regulated and proper accounts maintained as provided in clause 10 of the contract. The theoretical consumption of steel shall be worked out as per procedure prescribed in clause 42 of the contract and shall be governed by conditions laid therein. In case the consumption is less than theoretical consumption including permissible variations recovery at the rate so prescribed shall be made. In case of excess consumption no adjustment need to be made.

(9) The steel brought to site and the steel remaining unused shall not be removed from site without the written permission of the 'Engineer-in-charge.

Condition/Provisions for procurement of cement by the contactor:

1. The contractor shall procure 43 grade ordinary Portland cement conforming to IS 8112/Portland Pozzolana Cement conforming to IS: 1489(Part -1), as required in the work, from reputed manufactures of cement such as ACC, Ultratech, Vikram, Shree Cement, Ambuja, Jaypee Cement, Century Cement & J.K. Cement or from any other reputed cement manufacturer having a production capacity not less than one million tones per annum as approved by Engineer- in-charge.

The Tenderers may also submit a list of names of cement manufacturers which they propose to use in the work. The tender accepting authority reserves right to accept or reject name(s) of cement manufacturers(s) which the tendere proposes to use in the work. No change in the tendere rates will be accepted if the tender accepting authority does not accept the list of cement manufacturers, given by the tenderer, fully or partially. The supply of cement shall be taken in 50kg bags bearing manufacturer's name and ISI marking. Samples of cement arranged by the contractor shall be taken by the Engineer-in-charge and got tested in accordance with provisions of relevant BIS code,the same shall stand rejected,and it shall be removed from the site by the contractor at his own cost within a week's time of written order from the Engineer-in-charge to do so.

2. Double lock provision shall be made to the cement Godown. The keys of one lock shall remain with the Engineer-in-charge or his authorized representative and the keys of the other lock shall remain with the contractor. The contractor shall be responsible for the watch and ward and safety of the cement godown. The contractor shall facilitate the Inspection of the cement Godown by the Engineer-in-charge at any time.

3. The cement shall be got tested by the Engineer-in-charge and shall be used on the work only after satisfactory test results have been received. The contractor shall supply free of charge the

cement required for testing including its transportation cost to testing laboratories. The cost of tests shall be borne by the contractor/ department in the manner indicated below:

(a) By the contractor, if the results show that the cement does not conforms to relevant BIS codes.

(b) By the Department,if the results show that the cement conforms to relevant BIS codes.

4. The actual issue and consumption of cement on work shall be regulated and proper accounts maintained as provided in clause10 of the contract. The theoretical consumption of cement shall be worked out as per procedure prescribed in clause 42 of the contract sand shall be governed by conditions laid therein. In case the cement consumption is less than theoretical consumption including permissible variation, recovery at the rate so prescribed shall be made. In case of excess consumption no adjustment need to be made.

5. The cement brought to the site and the cement remaining unused after completion of the work shall not be removed from site without the written permission of the Engineer- in -charge.

6. The damaged cement shall be removed from the site immediately by the contractor on receipt of the noice in writing from the Engineer-in-charge or the Engineer-in-charge shall get it removed at the cost of the contractor.

7. The cement shall be brought at site in bulk supply of approximately 50 tonnes or as decided by the Engineer-in-charge. The cement Godown of the capacity to store a minimum of 2000 bags of cement shall be constructed by the contractor at site of work for which no extra payment shall be made.

8. For works where requirement of cement if a work is less than 400 bags, the conditions mentioned at SI.NO. 1to7 shall be followed with the relaxation that the cement can be procured from the authorised sole distributor of the approved cement manufacturing company in India only with the following conditions:

i) The sole distributor shall give invoice/ bill of cement sold to contractor indicating batch number/lot number along with proof (attested copy of bills of manufacturer) that the cement sold to contractor has been procered by the distributor directly from the reputed cement manufacturer having a production capacity not less than one million tonne per annum with attested copy of quality test certificate issued by cement manufacturer for the batch/lot number.

ii) Every consignment of cement must have identification marks on packages (date of manufacture, grade and type of cement).

iii) Cement brought at site shall not be more than 6 weeks old from the date of manufacture.

This issue with the prio approval of competent authority.

Annexure- I

Special Conditions for Steel

SI.	Item	Checkpoint	Remarks
		a. Factory address and registration no.	

1	Steel producer having manufacturing facilities at plant	b. Certificate of manufacturing process	
		c.Refining process of steel producer	
		c.1 BF-BOF route	
		C.2 Corex- BOF route	
		c.3 DRI- EAF route	
		With documentary evidence either for BOF or EAF	
		d. Steel plant having infrastructure for producing sponge iron, billete and TMT Rebars	
		e. Production and quality flow chart	
		f.Plant Evaluation and process verification	
		g. List of Plant & machinery	
2	Established	Document verification for :	
		a. Govt/ PSU Approvals	
		b. Supply orders of TMT Re-bars in Govt,Project(Minimum-5years)	
		c. Verification of direct supply orders to any state/ central Govt. Department	
		d.User certificate Issued by any Govt. Department directly	
3	Indigenous	Document verification for :	
		a. Certificate of Incorporation	
		b. Memorandum of Articles of Association	
		c. Credit rating of the company from CARE/CRISIL/ICRA should not be C/D grade(minimum last 3 years)	
		a. Test Results from Govt./NABL accredited laboratories	
		b.In- house testing facility for physical/ chemical tests(NABL accredited)	

10mm to 16 mm dia bars	One sample for each 35	One sample for each 40tonnes or part there of
Over 16 mm dia bars	One sample for each 45 tonnes or part thereof	One sample for each 60 tonnes or part there of

(7) The contractor shall supply free of charge the steel required for testing including its transportation to testing laboratories. The cost of tests shall be borne by the contractor.

(8) The actual issue and consumption of steel on work shall be regulated and proper accounts maintained as

4	Reliable	d. Calibration certificate	
		e. List of lab equipment	
		e.1 Sectrometer	
		e.2 Computerized UTM	
5	Use of Iron- Ore/Processes iron are as basic raw materials	Verification of Iron- ore/ Process Iron are Invoices	
6	In-house rolling facility	Plant verification to identify in-house rolling facilities,production of liquid steel & crude steel	
7	Licenses & certificate	a. ISO 9001:2008 Certification	
		b. ISO 14001:2004 Certification	
		c.OHSAS 18001:2007 Certification	
		d.IS1786:2008(TMT Re- bars)	
		e. IS 2830:1992(Billets)	
8	Product Range	TMT Re- bars FE 415/415D/500/500D/550/550D	
		CRS(Corosion Resistant) & EQR(Earthquake Resistant) TMT Re-bars Size 8 to 36mm dia	

Notes:

DRI- EAF-> Direct Reduce Iron- Electric ARC Furnace

BF- BOF->Blast Furnaco- basic oxygen furnace

Corex-BOF->Corex Furnaco – Basic Oxygen furnace

TECHNICAL SPECIFICATION FOR ALUMINIUM WORK

GENERAL

1.1.1 All aluminum work shall be free from defects, impairing strength , durability appearance and shall be of the best commercial quality for the purpose specified, made with structural properties to withstand safety strains, stresses to which they shall be normally subjected. All sections shall be of approved extruded tubular anodized aluminum section from the approved manufactures such as HINDALCO, CENTURY, BHORUKA,JINDAL,INDAL& MAHAVIR, as per architectural drawings and as revelent I.S. Specifications.

1.1.2 The contractor shall provide all the materials, operations, mentioned or scheduled including all labour, materials fixing devices, equipments and incidental necessary as per for their completion.

1.1.3 The contractor shall shop submit drawings and samples of each type of doors, windows, railing, curtain glazing and other items of aluminum work to the Engineer-in charge/Architect for approval .The Shop drawings shall show full size sections of doors and windows etc, thickness of aluminum sections, details of construction hardware as well as connections of doors, windows and other aluminum work to adjacent work. Shop drawings shall be based on actual dimensions available on site, which should not vary from those on drawings by 1.5mm.

1.1.4 Aluminum doors and shutters shall be manufactured by an approved manufacturer and shall be of sections, sizes combination and details show on the architectural drawings. The frame member shall be of one piece and glazing bars shall be threaded or interlocked.

1.1.5 Glazing for doors and windows shall be of specified thickness and approved quality and shall confirm to specification of glazing. Fixing of glazing shall be done with aluminum snap –on beading as per detailed drawing and instructions. Necessary rubber gasket of approved make shall be provided.

1.1.6 The contractor shall be responsible for the doors and windows shutters being set straight, plumb and level for their satisfactory operation after the fixing is complete.

1.1.7 All fittings shall be got approved from the architect. The fittings and aluminum work shall be fixed after all plastering is complete and shall be wrapped and protected until the complete aluminum work is washed with mild solution of alkali soap and water .

FABICATION

1.1.8 All fabrication shall be done with workmen who are skilled in the trade and fully equipped to carry out phases of fabrication in accordance with the best accepted practice and as show on drawing. The detail of equipment possessed by the contractors shall be provided which should conclusively prove that all facilities required to execute the work are available.

1.1.9 All aluminum section shall be anodized or powder coated to required shade to natural matt shade of 15micron thickness confirming to IS: 1868 of AC 10grade.

1.1.10 All windows, glazing etc shall be made completely water proof and necessary silicon

/polysulphide sealant etc. as the rate quoted shall be inclusive of cost of sealent.

1.1.11 Taking into consideration varying profile of aluminium sections being extruded by approved manufacturers and their availability in time as required, the contractors shall prepare detailed shop drawings of proposal using suitable section based on architectural design/ drawing to meet the performance and other parameter laid down for the work. The section , profile , weight and suitability shall meet the requirement of specifications.

1.1.12 All joints shall be accurately fabricated and be hairline appearance. The finished surface shall be free from visible defects.

1.1.13 Doors, windows, frames shall be fixed to concrete or brick work with approved metal fastners. Method of fixing of the hardware shall be as approved by Engineer-in –charge before mass fabrication.

1.1.14 All hardware used shall conform to the relevant IS specification. Design ,quality, type, number and fixing of the hardware shall be as approved by Engineer-In –Chargre.

1.1.15 A thick layer of the clear transparent lacuer based on Methacrylates or cellouse Butyrate shall be applied on the glazing before they are brought on the site. The lacquer shall be removed on completion of erection.

1.1.16 No visual variation in shade shall be permitted.

1.1.17 All screws shall be of stainless steel and of the shade as that of aluminum work. Gasket for retaining glass shall be of heavy extended neoprene.

2..1.11 The corners of the frame shall be truly at right angle. All members shall be accurately machine willed and fitted to form hairline joints. The joining accessories such as cleat, brackets etc. shall be such material as to not cause any bimetallic corrosive action.

1.1.18 All frame members shall be washed with a suitable thinner and left in a finished condition in approved uniform appearance and free all marks and blemishes. The glass panes shall be thoroughly washed and cleaned before the work is handed over.

Glass

1.

3.1 The glass shall be of specified thickness and approved make. Clear glass used in glazing, open able and fixed doors, windows, etc shall provide clear, completely undisrdistored vision and reflection . It shall be free from bubbles, waves or blemishes.

3.2 Tinted glasses have same quality and specifications as indicated above for clear glass. It shall however be transparent glass tinted or bronze/blue/green/ smoke grey shade as specified.

4 WOOD WORK

4.1 Materials

4.1Timber:

4.1.1 Timber as specified shall be used and shall be free from decay, fungal growth, boxed heart, pitch pockets or streaks on the exposed edges, splits and cracks.

4.1.2 The maximum permissible moisture content of timber used for different purposes shall be as per IS:287-1973

4.1.3 Unless & otherwise specified, air seasoned timber shall be used

4.2 Plywood Boards:

4.2.1 Plywood shall be of BWP grade or BWR grade as per IS:303. Face veneers may be either commercial or decorative on both sides or one side commercial and the other side decorative as specified. Unless otherwise stated, only BWP grade ply wood shall be used.

4.2.2 Moisture content of the plywood boards when tested in accordance with IS: 1734(part- I) shall not be less than 5 % and more than 15%.

4.3 Particle Boards:

4.3.1 The particle boards shall be flat pressed with single, three or multi layers and graded and of type I conforming to IS: 3087. Both surfaces of the boards shall be sanded to obtain a smooth finish. Adhesive used for bonding shall be BWP type synthetic resin conforming to IS: 848.

4.4 Veneered Particle Boards:

4.4.1 Veneered particle board shall be exterior(Grade I) as per IS:3097. Both surfaces of the boards shall be sanded to a smooth finish. Adhesive used for bonding shall be BWP synthetic resin conforming to IS: 848.

4.5 Block Board:

4.5.1 1.5.1 Block boards shall be grade I (Exterior Grade) conforming to IS: 1659. Both surfaces of the boards shall be sanded to a smooth finish. The adhesive used for bonding shall be BWP type synthetic resin conforming to IS:848 for grade I block boards

4.6 Glass, Frosted Glass:

4.6.1 Sheet glass shall be flat, transparent and clear. Sheet glass shall be ordinary quality conforming to IS: 2835. Sheet glass of 4 mm nominal thickness weighing not less 10kg/sqm shall be used for glass panel's upto 0.5sqm. For panels exceeding 0.5 sqm in area, the thickness of glass shall be specified

DOOR, WINDOW &VENTILATOR FRAMES:

Timber for door, window and ventilators frames shall be as specified. Timber shall be sawn in the direction of grains. All members of the frame shall be straight without any warp or bow. Frames shall

have smooth, well planed (wrought) surfaces except the surfaces touching the walls, hinters, sill etc. which mabe be left clean sawn.

The frames shall have dovetail joints. The jamb posts shall be through tenoned into the mortise of the transoms to the full thickness of the transoms. The contact surface of tenon and mortise before pulling together shall be glued with poly vinyl acetate dispersion based adhesive conforming to IS: 4835. Each assembled door frame shall be fitted with a temporary stretcher and a diagonal brace on the rebated faces.

The surfaces of the frames abutting masonry or concrete and the portions of the frames embedded in floors shall be given a coating of coal tar. Frames shall be fixed to the abutting masonry or concrete with hold fasts or metallic fastener as specified. A minimum of three hold fasts shall be fixed on each side of door and window frames, one at centre point and other two at 30cm from the top and bottom of the frames, if the height of the frames is more than 1.00pm. Hold fasts and metallic fasteners shall be measured and paid for separately unless specified specifically.

Measurements:

Length of each member shall be measured over all to the nearest cm so as to include projection for tenons . Width and thickness shall be measured to the nearest mm and the quantity shall be worked out in unit 10 cudm in whole numbers.

Rate:

The rate shall include the cost of material and labour involved, in all the operations described above except the hold fasts or metallic fasteners which will be paid for separately unless specified specifically.

ANELLED GLAZED OR PANELLED AND GLAZED SHUTTERS:

The shutters may be single or multi-paneled as shown in drawings or as directed by Engineers-in-charge. Timber for for framework, material for panel inserts and thickness of shutters shall be as specified. All members of the shutters shall be straight without any wrap and shall have smooth well-planned face at right angles to each other.

The timber for frame work shall be of some species and shall be sawn in the directions of grains. The stiles and rails shall be joined to each other by plain or haunched mortise and tenon joints and the rails shall be inserted 25mm short of the width of the stiles. The bottom rails shall have double tenon joints. Others rails shall have single tenon joints. The lock rails of the door shutter shall have its centre line at a height of 800 mm from the bottom of the shutters.

The contact surfaces of tenon and mortise shall be treated, before putting together, with bulk type synthetic resin adhesive conforming to IS : 851 and period with 10mm dia hard wood dowels or bamboo pins. The width of stiles and rails shall not be less than 75mm.

In case of double leave shutters, the meeting of the stiles shall be rebated by one third the thickness of the shutter.

The panel inserts shall be either framed into the grooves or housed in the rebate of stiles and rails. Timber, plywood, hard board particle panel shall be fixed only with grooves.

The depth of the groove shall be 12 mm . Panel inserts shall be framed into the grooves of stiles and rails to the full depth of the groove leaving space of 1.5mm.

Side hung shutters of height upto 1.2m, each leaf shall be hung on two hinges at quarter points and shutter of height more than 1.2m, each leaf shall be hung on three hinges. Top hung and bottoms hung shutters shall be hung on two hinges.

Measurements:

The overall length and width of the frame work of the shutters shall be measured nearest to a cm in fixed position and the area calculated in square meters correct to two places of decimals. No deduction shall be made to form panel openings or louvers.

For paneling of each type or for glazed panel, length and width of opening for panels inserts or glazed panels shall be measured correct to a cm before fixing the beading and the area shall be calculated to the nearest 0.01 sqm. The portions of the panel insert or glazed panel inside the grooves or rebates shall not be measured.

Rate:

The rate includes the cost of materials and labour involved in all the operations described above. The frame work and paneling of each type or glazed panels shall be paid separately. The rate for frame work includes the cost of butt hinges and necessary screws.

FLUSH DOORS SHUTTERS:

Flush door shutters shall have a solid core and may be of decorative or non decorative type as per IS: 2202(Part I). The shutter shall be of specified thickness. All four edges of shutters shall be square. The shutter shall be free from twist or warp in its plane. The moisture content in timbers used in the manufacture of flush door shutters shall not be more than 12% when tested according to IS: 1708.

Lipping where specified shall be provided internally on all edges of the shutters. Lipping shall be done with battens of Ist class hard wood or as specified of depth not less then 25mm. Joints will not be permitted in lipping.

Adhesive used for bonding various components of flush door shutters shall conform to BWP type conforming to IS: 848.

Flush door shutters shall be subjected to the following tests:

a) End immersion test: There shall be no delamination at the end of the test.

b) Knife Test: The shutter should pass the test.

c) Adhesion test: The shutter should pass the test.

Measurements:

The length and width of the shutters shall be measured to the nearest cm in closed position covering the rebates of the frames but excluding the gap between the shutter and the frame. Overlap of two shutters shall not be measured. All work shall he measured net as fixed and area calculated in square meters to nearest two places of decimal.

Rate:

The rate includes the cost of material and labour involved in all the operations described above.

DOOR AND WINDOW FITTINGS:

a. The Fittings shall be of aluminium. These shall be well made, reasonably smooth and free from sharp edges and corners, flaws and other defects. Screw holes shall be counter sunk to suit the head of screws.

b. Aluminium fittings shall be anodized to natural finish or dyed. Anodic coating shall not be less than grade AC-10 of IS: 1868. Chromium plated brass screws or stainless steel screws shall be used for fixing aluminium fittings. Fitting shall be fixed in proper position as shown in the drawings or as directed by Engineer-in-charge/Consultant. These shall be truly vertical or horizontal. Screw shall be driven home with screw driver and not hammered in. Recesses shall be cut to the exact size and depth for the counter sunking of hinges.

c. Butt Hinges:

d. These shall be manufactured from extruded sections. These shall be well made and free from flaws and defects of all kinds. These shall conform to IS: 205.

e. Piano Hinges:

f. These shall be made of aluminium alloy sheet and shall be anodized. The anodic coating shall not be less than the grade AC10 of IS:1868.

g. Sliding door Bolts: These shall be made of aluminium alloy and shall generally conform to IS:2681. Aluminium sliding door bolts shall be anodized. In case of single leaf door, When iron socket plate or a brass or aluminium fixing bolts (or sliding door bold) cannot be fixed , hole of suitable size shall be drilled in the door frame and an iron or brass plate cut to shape shall be fixed at the face of the hole.

h. Tower Bolts:

i. Aluminium Barrel tower bolts with barrel and bolt shall be of extruded sections of aluminium alloy. The knob shall be properly screwed to the bolt and riverted at the back. These shall generally conform to IS: 204(PartI & II)

j. Pull Bolt:

k. Aluminium pull bolts shall be anodized and the anodic coating shall to be less than grade AC10 of IS: 1868. The bolt shall be 10mm in diameter and the fixing plate 3mm thick

1.8 Mortice Lock & Latch:

This shall generally conform to IS: 2209

1.9 Handles:

These should generally conform to IS: 208 and shall be of aluminium of specified size and of shape and pattern as approved by Engineer-in-charge/Consultant.

Tre mix Flooring

Trimix flooring thickness shall 75mm thick with reinforced cement concrete of grade M25 with 20mm down size graded crushed stone aggregate/gravel in floors etc. laying in alternate panels of maximum 4x4mtr to required levels and followed by suction drying process including leaving dowels, pockets openings, grooves 3x12mm, side shuttering, vibrating by poker/needle vibrator surface vibrator, mechanical floating and power trowelling, curing, and rendering if required to give smooth and even surface, cutting of grooves at construction joints and filling the same with mastic sealent of approved quality including heavy duty non-metallic integrated floor hardener dosing @ 4 kg per sqm as per the manufacturers specifications (make of Fosroc/ BASF). All complete as specified and directed and including execution by specified and experienced agency.

Measurements

It shall be measured in cubic meteres correct to two place of decimal.

Rate

The rate shall include the cost of material, labour and machinery involved in all the operations described above.

11.15 PRESSED CERAMIC TILE FLOORING

11.15.1 Pressed Ceramic Tiles

The tiles shall be of approved make and shall generally conform to IS 15622. They shall be flat, and true to shape and free from blisters crazing, chips, welts, crawling or other imperfections detracting from their appearance. The tiles shall be tested as per IS 13630.

Classification and Characteristics of pressed ceramic tiles shall be as per IS 13712.

The tiles shall be square or rectangular of nominal size. Table 1, 3, 5, and 7 of IS 15622 give the modular preferred sizes and table 2, 4, 6 and 8 give the most common non modular sizes. Thickness shall be specified by the manufacturer. It includes the profiles on the visible face and on the rear side. Manufacturer/supplier and party shall choose the work size of tiles in order to allow a nominal joint width upto 2mm for unrectified floor tiles and upto 1mm for rectified floor tiles. The joint in case of spacer lug tile shall be as per spacer. The tiles shall conform to table10 of IS 15622 with water absorption 3 to 6% (Group BII).

The top surface of the tiles shall be glazed. Glaze shall be either glossy or matt as specified. The underside of the tiles shall not have glaze on more than 5% of the area in order that the tile may adhere properly to the base. The edges of the tiles shall be preferably free from glaze. However, any glaze if unavoidable, shall be permissible on only upto 50 per cent of the surface area of the edges.

11.15.2 Coloured Tiles

Only the glaze shall be coloured as specified. The sizes and specifications shall be the same as for the white glazed tiles.

11.15.3 Decorative Tiles

The type and size of the decorative tiles shall be as follows:

(i) **Decorated white back ground tiles**

The size of these tiles shall be as per IS 15622.

(ii) **Decorated and having coloured back-ground**

The sizes of the tiles shall be as per IS 15622.

11.15.4 Preparation of Surface and Laying

11.15.4.1 Base concrete or the RCC slab on which the tiles are to be laid shall be cleaned, wetted and mopped. The bedding for the tile shall be with cement mortar 1:4 (1 cement: 4 coarse sand) or as specified. The average thickness of the bedding shall be 20 mm or as specified while the thickness under any portion of the tiles shall not be less than 10 mm.

11.15.4.2 Mortar shall be spread, tamped and corrected to proper levels and allowed to harden sufficiently to offer a fairly rigid cushion for the tiles to be set and to enable the mason to place wooden plank across and squat on it.

11.15.4.3 Over this mortar bedding neat grey cement slurry of honey like consistency shall be spread at the rate of 3.3 kg of cement per square metre over an area upto one square metre. Tiles shall be soaked in water washed clean and shall be fixed in this grout one after another, each tile gently being tapped with a wooden mallet till it is properly bedded and in level with the

adjoining tiles. The joints shall be kept as thin as possible and in straight lines or to suit the required pattern.

11.15.4.4 The surface of the flooring during laying shall be frequently checked with a straight edge about

2 m long, so as to obtain a true surface with the required slope. In bath, toilet W.C. kitchen and balcony/verandah flooring, suitable tile drop or as shown in drawing will be given in addition to required slope to avoid spread of water. Further tile drop will also be provided near floor trap.

11.15.4.5 Where full size tiles cannot be fixed these shall be cut (sawn) to the required size, and their edge rubbed smooth to ensure straight and true joints.

Tiles which are fixed in the floor adjoining the wall shall enter not less than 10 mm under the plaster, skirting or dado.

11.15.4.6 After tiles have been laid surplus cement slurry shall be cleaned off.

11.15.5 Pointing and Finishing

The joints shall be cleaned off the grey cement slurry with wire/coir brush or trowel to a depth of 2 mm to 3 mm and all dust and loose mortar removed. Joints shall then be flush pointed with white cement

added with pigment if required to match the colour of tiles. Where spacer lug tiles are provided, the half

the depth of joint shall be filled with polysulphide or as specified on top with under filling with cement grout without the lugs remaining exposed. The floor shall then be kept wet for 7 days. After curing, the

surface shall be washed and finished clean. The finished floor shall not sound hollow when tapped with a wooden mallet.

11.15.6 Measurements

Length and breadth shall be measured correct to a cm before laying skirting, dado or wall plaster and the area calculated in square metre correct to two places of decimal. Where coves are used at the junctions, the length and breadth shall be measured between the lower edges of the coves.

No deduction shall be made nor extra paid for voids not exceeding 0.20 square metre. Deductions for ends of dissimilar materials or other articles embedded shall not be made for areas not exceeding

0.10 square metre.

Areas, where glazed tiles or different types of decorative tiles are used will be measured separately.

11.15.7 Rate

The rate for flooring shall include the cost of all materials and labour involved in all the operations described above, For tiles of sizes upto 0.16 sqm. unless otherwise specified in the description of the item. Nothing extra shall be paid for the use of cut (sawn) tiles in the work.

Extra over and above the normal rate for white tiles shall be paid where coloured or any other type of decorative tiles have been used.

11.16 PRESSED CERAMIC TILE FLOORING (VITRIFIED TILE FLOORING)

11.16.1 Operations as described in 11.15.1 to 11.15.6 shall be followed except the tiles shall conform to Table 12 of IS 15622 (Tiles with water absorption E ≤ 0.08 per cent Group BIa) and the joint thickness in flooring shall not be more than 1mm.

11.16.2 Rate

The rate for flooring shall include the cost of all materials and labour involved in all the operations described above. Nothing extra shall be paid for the use of cut (sawn) tiles in the work.

11.17- Not applicable

11.18 PRESSED CERAMIC TILES IN SKIRTING AND DADO

11.18.1 The tiles shall be of approved make and shall generally conform to IS 15622. The tiles shall be pressed ceramic covered by a glaze thoroughly matured and fitted to the body. The tiles shall be sound, true to shape, flat and free from flaws and other manufacturing defects affecting their utility.

The top surface of the tiles shall be glazed. The underside of the tiles shall not have glaze on more than 5% of the area in order that the tile may adhere properly to the base. The edges of the tiles shall be free from glaze, however, any glaze if unavoidable shall be permissible on only upto 50 per cent of the surface area of edges.

The glaze shall be free from welts, chips, craze, specks, crawlings or other imperfections detracting from the appearance when viewed from a distance of one metre. The glaze shall be either glossy or matt as specified. The glaze shall be white in colour except in the case of coloured tiles when colours shall be specified by the Engineer-in-Charge. There may be more than one colour on a tile.

11.18.1 (a) Dimensions and Tolerances

Glazed pressed cramic tiles shall be made square or rectangular in sizes Table 1, 3, 5 & 7 of IS 15622 give the modular sizes and table 2, 4, 6 & 8 of IS 15622 gives the sizes of non modular tiles. The tiles shall conform to IS 15622 for dimensional tolerance, physical and chemical properties.

Half tiles for use as full tiles shall have dimensions which shall be such as to make the half tiles when jointed together (with 1 mm joint) match with dimensions of full tiles. Tiles may be manufactured in sizes other than those specified. above.

The thickness of the tiles shall be 5 mm or 6 mm or as specified.

The dimensions of fittings associated with the glazed tiles namely cover base, round edge tile, angles corner cups, ridge and legs, cronices and capping beads shall be of the shape and dimensions as required and the thickness of fittings shall be the same as the thickness of tiles given above.

11.18.2 Preparation of Surfaces

The joints shall be raked out to a depth of at least 15 mm in masonry walls.

In case of concrete walls, the surface shall be hacked and roughened with wire brushes. The surface shall be cleaned thoroughly, washed with water and kept wet before skirting is commenced.

11.18.3 Laying

12 mm thick plaster of cement mortar 1:3 (1 cement : 3 coarse sand) mix of as specified shall be applied and allowed to harden. The plaster shall be roughened with wire brushes or by scratching diagonal at closed intervals.

The tiles should be soaked in water, washed clean, and a coat of cement slurry applied liberally at the back of tiles and set in the bedding mortar. The tiles shall be tamped and corrected to proper plane and lines. The tiles shall be set in the required pattern and jointed. The joints shall be as fine as possible. Top of skirting or dado shall be truly horizontal and joints truly vertical except where otherwise indicated. Odd size/cut size of tile shall be adjusted at bottom to take care of slope of the flooring. Skirting and dado shall rest on the top of the flooring. Where full size tiles cannot be fixed these shall be cut (sawn) to the required size and their edges rubbed smooth. Skirting /dado shall not project from the finished “surface of wall” by more than the tile thickness, undulations if any shall be adjusted in wall.

11.18.4 Curing and Finishing

The joints shall be cleaned off the grey cement grout with wire/coir brush or trowel to a depth of 2 mm to 3 mm and all dust and loose mortar removed. Joints shall then be flush pointed with white cement added with pigments if required to match the colour of tiles. The work shall then be kept wet for 7 days.

After curing, the surface shall be washed and finished clean. The finished work shall not sound hollow when tapped with a wooden mallet.

11.18.5 Measurements

Length shall be measured correct to a cm. Height shall be measured correct to a cm in the case of dado and 5 mm in the case of riser and skirting. The area shall be calculated in square metre, correct to two places of decimal. Length and height shall be measured along the finished face

of the skirting or dado including curves where specials such as coves, internal and external angles and beads are used. Where cornices are used the area of dado shall be measured excluding the cornices. Nothing extra will be paid for cutting (sawn) the tiles to sizes.

Areas where coloured tiles or different types of decorative tiles are used will be measured separately to be paid extra over and above the normal rate for white tiles.

11.18.6 Rates

The rate shall include the cost of all material and labour involved in all the operations described above, for tiles of sizes upto 0.14 sqm. unless otherwise specified in the description of the item. The specials such as coves, internal and external angles and beading shall be measured and paid for separately. The rate shall not include cost of cornices which shall be measured and paid for in running meters separately.

Full Body Vitrified tile

Parking Flooring with full body Vitrified tiles in different sizes 12-15mm thick, make of tile , water absorption less than 0.05 % and conforming to I.S. 4457:2007, of approved make, in all colors & shade, ,over 20 mm thick bed of cement mortar 1:3 (1 cement: 3 coarse sand), including PVC spacers 5mm thick with epoxy grouting the joints & matching pigments etc. complete.

Measurements

Length shall be measured correct to a cm. Height shall be measured correct to a cm in the case of dado and 5 mm in the case of riser and skirting. The area shall be calculated in square metre, correct to two places of decimal. Length and height shall be measured along the finished face of the skirting or dado including curves where specials such as coves, internal and external angles and beads are used. Where cornices are used the area of dado shall be measured excluding the cornices. Nothing extra will be paid for cutting (sawn) the tiles to sizes.

Areas where coloured tiles or different types of decorative tiles are used will be measured separately to be paid extra over and above the normal rate for white tiles.

Rates

The rate shall include the cost of all material and labour involved in all the operations described above, for tiles of sizes upto 0.14 sqm. unless otherwise specified in the description of the item. The specials such as coves, internal and external angles and beading shall be measured and paid for separately. The rate shall not include cost of cornices which shall be measured and paid for in running meters separately.

Water proofing

22.5 WATER PROOFING TREATMENT IN SUNKEN PORTION OF WCs, BATHROOMS ETC.

22.5.1 Preliminaries to be attended

The preliminaries shall be attended as described in clause 22.3.1.

22.5.2 Preparing Surface, Fixing Pipes and Fittings

In this case, unlike as described in clause 22.3.2, no hacking of surface need be made, but only extra mortar sticking to the surface should be removed and the surface should be cleaned thoroughly. Fixing 'P' trap etc. shall be done as described in Clause 22.3.2.

22.5.3 Providing and Laying of Slurry for First Layer

The consistency of the slurry should be such as to cover the desired area by using 0.488 kg of blended cement per sqm of area.

On deciding the correct quantity of water required per sqm. area the required quantity of slurry should be prepared which can be applied over the desired surface within half an hour of mixing with

0.488 kg. of grey cement + 0.253 kg. water proofing compound as per manufacturer specifications + x

litres of water per sqm. area and the required quantity of slurry thus prepared should only be used for first application.

The first layer shall be applied with painting brushes over the specified and dampened area carefully including the corners, holes on the surfaces and joints of pipes in concrete etc. and the application should continue at least upto 150 mm height of fixtures of pipes from the surface. The surface on application shall be air cured for 4 hours.

22.5.4 Providing and Laying of Slurry for Second Layer

The quantity of slurry required for second application to be covered within an hour of mixing shall be prepared with 0.242 kg. Cement + 0.126 kg. Water proofing compound + y litres of water per sqm. area

and the required quantity of slurry thus prepared should only be used for second application.

The application of 2nd layer of slurry is same as for first layer as detailed in clause 22.5.3.

The applied surface shall be allowed to air cure for 4 hours and thereafter water curing shall be done for full 48 hours.

In case no further work as described above is to be taken up immediately on completion of water proofing treatment due to any reason it is recommended to protect the treated portion with cement plaster 1:4 as a protective layer for which separate payment shall be made to the contractor.

22.5.5 Measurement

Length and breadth shall be measured along the finished surface correct to a cm and area shall be worked out to nearest 0.01 sqm.

22.5.6 Rate

The rate shall include the cost of all labour and materials involved in all the operations described above. The cost of plastering shall be measured and paid for separately.

22.7 INTEGRAL CEMENT BASED WATER PROOFING TREATMENT WITH BRICK BAT COBA

22.7.1 Before taking up the work the preliminaries to be attended shall be exactly same as described in clause 22.6.1.

22.7.2 Preparing the Surface

The surface of the slab should be roughened by scrapping when the slab concrete is still green, however, the surface need not be hacked. In case the slab is already cast and surface fairly finished, the same shall be cleaned neatly of all mortar droppings, loose materials etc with brooms/cloth.

22.7.3 Providing and Laying of Slurry under Base Coat

The quantity of water required to prepare the slurry with 2.75 kg. of blended cement to be painted over an area of 1 sqm. Shall be calculated exactly as described in clause 22.5.3.

Depending upon the area of surface that has to be covered, the required quantity of slurry should be prepared using 2.75 kg. blended cement + water per sqm. area to be covered, taking particular care to see that only that much quantity of slurry shall be prepared which can be used within half an hour of preparation i.e. before the initial setting time of cement.

The prepared slurry shall be applied over the dampened surface with brushes very carefully, including the joints between the floor slab and the parapet wall, holes on the surfaces, joints of pipes, masonry/concrete etc.

The application of the slurry should continue upto a height of 300 mm on the parapet wall and also the groove as shown in Fig. 22.6. The slurry should also be applied upto a height of 150 mm over pipe projections etc.

22.7.4 Laying Base Coat 20 mm thick

Immediately after the application of slurry and when the application is still green, 20 mm thick cement plaster as base coat with cement mortar 1:5 (1 blended cement : 5 coarse sand) shall be evenly applied over the concrete surface taking particular care to see that all the corners and joints are properly packed and the application of the base coat shall be continued upto a height of 300 mm over the parapet wall.

22.7.5 Laying Brick Bat Coba

Brick bat of size 25 mm to 115 mm out of well burnt bricks shall be used for the purpose of brick bat coba.

The brick bats shall be properly dampened for six hours before laying.

Brick bats shall be laid to required slope/gradient over the base coat of mortar leaving 15-25 mm gap between two bats. Cement mortar 1:5 (1 blended cement: 5 coarse sand) shall be poured over the brick bats and joints filled properly. Under no circumstances dry brick bats should be laid over the base coat.

The haunches/gola at the junction of parapet wall and the roof shall be formed only with brick bat coba as shown in Fig. 22.6.

In case the brick bat coba is laid on the base coat immediately on initial set there will be no necessity of applying cement slurry over the base coat before laying the brick bat coba. However, if the brick bat coba is to be laid on the subsequent day, cement slurry prepared as described in clause 22.7.3 shall be applied over the top surface of the base coat, then only the brick bat coba shall be laid.

22.7.6 Application of Slurry over Brick Bat Coba

After two days of curing of brick bat coba cement slurry prepared as per clause 22.7.3 shall be applied on the surface of brick bat coba The application of slurry shall be the same as described in clause 22.5.3 which should cover the haunches/gola, and the remaining small portion of parapet wall and also inside the groove as shown in the figure.

22.7.7 Laying Finishing Layer (Protective Coat)

Immediately on applying the cement slurry over the surface of the brick bat coba and when the slurry applied is still green, the fibre glass cloth as specified in clause 22.6.4 shall be spread evenly on the surface without any kink & pressed to see that no air spaces exist. The fibre glass cloth shall be taken up to a height of 300 mm on parapet walls & tucked in the groove specially prepared at that height. 20 mm thick layer of cement plaster, without leaving any joints shall be applied with cement mortar 1:4 (1 blended cement: 4 coarse sand) over the entire fibre glass cloth including the haunches/gola and the small portion on the parapet wall. The groove in the parapet wall over the haunches shall also be filled neatly packing the mortar firmly in the groove.

The surface of the finishing layer (protective coat) shall be neatly finished with cement slurry prepared as per clause 22.7.3. The finished surface shall be allowed to dry for a while and then pattern of 300 mm x 300 mm groove, 8 mm deep shall be made over the entire surface.

22.7.8 Curing and Testing the Treatment

The entire surface thus treated shall be flooded with water by making kiaries with weak cement mortar, for a minimum period of two weeks.

22.7.9 Measurement

The measurement shall be taken along the finished surface of treatment including the rounded and tapered portion at junction of parapet wall. Length and breadth shall be measured correct to a cm and area shall be worked out to nearest 0.01 sqm. No deduction in measurement shall be made for openings or recesses or chimney stacks, roof lights or khurras of area upto 0.40 sqm., nor anything extra shall be paid for making such openings, recesses etc. For areas exceeding 0.40 sqm., deduction will be made in the measurements for the full openings and nothing extra shall be paid for making such openings.

22.7.10 Rate

The rate shall include the cost of all labour and materials involved in all the operations described above.

GRC (Glass Reinforced Concreting)

1. CHARETERSTIC

Made up of Fine Slica Sand. Cement 53 Grade

Akali Resistant Glass Fiber manufactured by ‘NEG’ or equivalent.

Super plasticizer manufactured by ‘NEG’ or equivalent.

Or Super plasticizer manufactured by ‘BASF’ Genilium 51 or equivalent.

Polymers manufactured by ‘BASF’, Pdilite or equivalent

UV resistance Synthetic inorganic pigments should be used

pigmentation manufactured by ‘BAYFERROX (germany),Lanxess or equivalent

Casting material should be used for pigmentation manufactured by 'RECKLI' or equivalent

.

2. Technical specification

S.no	Material	Percentage	Manufacture Name	
1	Portland White Cement	47% to 48%	JK cement / Birla white	
2	White Quartz fine silica sand (Fine Graded and Selected)	47% to 48%	Procured locally	
3	Alkali Resistant 3% to 3.5% NEG - Japan Glass Fiber AR Zirconia 17%)	4% to 5%	NEG - Japan Owens Corning	
4	Super Plasiticizer	0.6% minimum	Glenium 51 make BASF	
5	Polymers	0.5% to 3%	Pidilite or BASF	
6	FRP Mould		In House Manufacturing	
7	**UV & Alkali Resistant** **Synthatic inorganic pigments**	Dose as per approved color	BAYFERROX (germany)/Lanxess	
8	**GFRC production shall be spray mix**			
9	**Water cement ratio .32 including water and admixture , acryalic etc**			
10	**Miniumum 7 days of mist/vapour curing after casting**			

Dry Density	:	1.8 to 2.0 ton / cubic meter
Water Absorption	:	Less than 7% of dry weight by

		Immersion over a period 24 hours.
Compressive Strength	:	M - 40 Grade concrete mix design With compressive strength of 400 kg/cm² (in 28 days cube testing)
Tensile Strength	:	4-7 MPa
Abrasion Resistance	:	Less than 2.0 for E.H.D.
Thermal Conductivity	:	1.63 W/MK at 3% moisture content 1.80 W/MK at 5% moisture content

2. Fixing Arrangement

1. The fixing of screen should be 'Dry Fixing" I.e to be done with stainless steel (SS-304) 'L' shaped brackets, fastners and pins, MS fabricated steel support system.

2. Before operating work , fixing arrangement should be approved by Engineer in charge/ Consultant.

3 Measurement

For payment Clear opening should be measured up two decimals

Metallic Ceiling

Gl Clip in Metal Ceiling System of 600x600 mm module which includes providing and fixing 'C' wall angle of size20x30x20 mm made of 0.5 mm thick pre painted steel along the perimeter of the room with help of nylon sleeves and wooden screws at 300 mm center to centre, suspending the main C carrier of size 10x38x10 mm made of G.I steel 0.7 mm thick from the soffit with help of soffit cleat 37x27x25x1.6 mm, rawl plugs of size 38x12 mm and C carrier suspension clip and main carrier bracket at 1000 mm c/c. Inverted triangle shaped Spring Tee having height of 24 mm and width of 34 mm made of Gl steel 0.45 mm thick is then fixed to the main C carrier and in direction perpendicular to it at 600 mm centers with help of suspension brackets. Wherever the main C carrier and spring T have to join, C carrier and spring T connectors have to be used. All sections to be galvanized @ 120 gms/sqm (both side inclusive), fixing with clip in tiles into spring with :

GI Metal Ceiling Clip in plain Beveled edge global white color tiles of size 600x600 and 0.5 mm thick with 25 mm height, made of G I sheet having galvanizing of 100 gms/ sqm (both sides inclusive) and electro statically polyester powder coated of thickness 60 microns (minimum), including factory painted after bending.

Measurements: Length and breadth of the roofing insulation shall be measured correct to a cm and the surface area worked out in square metre of the finished work.

No deduction shall be made for openings of areas upto 40 square decimetre. No extra payment will be made for any extra material or labour involved in forming such openings. For openings exceeding 40 square decimetre in area deduction for the full opening will be made, but nothing extra will be paid for any extra material/labour involved in forming such openings.

Rate : The rate shall include the cost of material and labour in providing and fixing

Aluminum Composite Panel (ACP)

Aluminium Composite Panel Cladding using **4mm thick sheet (0.5mm + 3mm + 0.5mm)** consisting of a core of 3mm polyethylene sandwiched between two skins of 0.5mm Aluminium alloy sheets with outer surface in desired color coating of PVDF paint in fully automatic coil coating process. The PVDF coated finished surface to be factory protected with self adhesive peel off foil tested to with stand at least 6 months exposure to local weathering conditions. The ACP Sheets shall be of **ALUCOBOND / EUROBOND / ALU DECOR / ALSTONE/ ALSTRONG** make or equivalent. complete in all respects as per the direction of engineer-in-charge. Only Skin area of ACP sheets fixed on the Building Facade Structure shall be measured on out to out basis and paid for. The Contractor shall include 1.5mm thick 38 x 38 hollow Aluminium tube for basic framework. The anchoring / bracing of the structural glazing to the RCC Beams / Slab / Columns shall be done with 3mm thick MS brackets of Approved design, Hot Dip Galvanised or duly powder coated up to 60 micron thickness with Black Colour Berger / Nerocoat Pure Polyester powder.Hilti/Fischer make anchor fasteners shall be used providing a minimum anchoring depth of 70mm in the concrete for anchoring the bracket to withstand the dead load of the structural glazing as well as stresses due to wind pressure etc. the glazing contractor shall also make arrangements with the anchor supplier – HILTI / FISCHER to carry out RANDOM PULL OUT TESTS at site after embedding the anchor in the concrete and submit the reports to the engineer-in-charge. All screw, bolts, nuts and washers used in the structural glazing shall be only stainless steel. The grooves between the ACP Panels shall be sealed by inserting Bond Breaking Backer Rod as manufactured by Supreme Industries and by application of High Performance Weather Silicone Sealant Non Staining Non Streaking as DC – 991 as manufactured by DOW CORNING or 605-S as manufactured by WACKER Silicones. Aluminium composit panel cladding on external shop front

Fixing Arrangement

M.S. structural work fabricated from standard sections, (MS rounds, flats, angles, channels etc.) including cutting to size, drilling, welding, including cost of fasteners, clamps in RCC structural members as directed, including two or more coats of synthetic paint over one coat of primer after surface preparation including cutting and making good walls/ floors etc for ACP facade work etc.

Measurement

Building Facade Structure shall be measured on out to out basis and paid for. Length and breadth of the ACP shall be measured correct to a cm and the surface area worked out in square metre of the finished work.

Rates

Rates are inclusive material and labour excluding the M.S structure

Glass work

Toughened glass

12mm tuffened glass panel of desired size , as per design/detail as show-window glass. The panels shall be fixed within aluminum concealled channels fixed in floor and ceiling with necessary rough ground for both, with a minimum expansion tolerance gap of 3mm on both sides of panel. The edges shall then be finished with absolute clear silicon. All edges of glass shall be straight polished to mirror finish.Provision shall be left for fixing of patch fittngs for fixing of glass door

Toughened or tempered glass is glass that has undergone processes of controlled thermal treatment to increase its strength.

Toughened glass is made from annealed glass that has been heated to approximately 650^{o}C and then rapidly cooled. Due to the increased heat treatment and rapid cooling of the glass, especially between the surface and the inside of the glass, the treatment produces different physical properties. This results in compressive stress on the surface and improved bending strength of glass.

Before toughening, the glass must be cut to size or pressed to shape. This is because once it is toughened, it cannot be re-worked on. Toughened glass is widely used in a number of applications.

Characteristics of Toughened Glass

Toughened glass is four to five times stronger than annealed glass of the same size and thickness against impact.Toughened glass has higher thermal strength and can withstand a high temperature differential upto 250°C.Toughened glass is considered as safety glass. It is difficult to break and even in the event of a breakage, disintegrates into small globules, which are relatively harmless.

Toughening does not alter the basic characteristics of glass such as light transmission and solar radiant heat properties.

After heat treatment, the surface of toughened glass has the same resistance to surface damage as annealed glass.Toughened glass cannot be cut, drilled or altered.

Heat soak test is recommended to be carried out on Toughened glass that is used for overhead and horizontal application, to prevent the spontaneous breakage caused due to nickel sulphide inclusion.

Properties of Toughened Glass:

Properties	**Toughened Glass**
Thermal Shock Resistance	Up to 250°C
Mechanical Strength	Four to five times stronger than annealed glass
Tensile Strength	65 MPa
Bending Strength	120-200 N/mm2
Surface Compression	> 95 MPa
Design Stress for Architectural Purposes	50 MPa
Fragmentation	Small round crystals
Conducive for Processing	Cannot be cut after Toughening

Sizes

Having different sizes 4mm to 12mm as per given in BOQ

Fixing arrangement

Fixed within aluminum concealled channels fixed in floor and ceiling with necessary rough ground for both, with a minimum expansion tolerance gap of 3mm on both sides of panel. The edges shall then be finished with absolute clear silicon. All edges of glass shall be straight polished to mirror finish.Provision shall be left for fixing of patch fittngs for fixing of glass door.

Measurement

Building Facade Structure shall be measured on out to out basis and paid for. Length and breadth of the clear opening shall be measured correct to a cm and the surface area worked out in square metre of the finished work.

Rates

Rates are inclusive material and labour

Note : Work done as per CPWD Specification

LIST OF APPROVED MANUFACTURERS/ SUPPLIER

6	RMC	ACC, BIRLA, Ultratech ,Lafarge or any RMC plant installed for MCD works.
7	Anti termite Treatment or	PCI
8	RCC Man Holes Frame & Cover & Footrest	K.K. or equivalent as approved by Engineer-in-Charge.
9	Anchor Fasteners/ chemicals	Hilti ,Fisher,Halfen
10	Structural Steel	SAIL, JSW,CORUS
11	PVC cover Block	Elmich, Aspitha Exports
12	Polypropylene Fibres	Fibermesh, Duracem,Eurofastner, Cetex
13	Adhesives & Grouts	Bal,Laticrete
14	Vitified Tile	Johnson,Nitco,Kajaria,Asian
15	Full body vitrified tile	Pavit, granito,Marbonite,Unistone
16	Silicon sealent	Dow Corning,GE Silicon,Wacker Silicon, Pidilite
17	Metal Doors	Shakti-Met Dor, Basic Arch Products,Radiant
18	Flush Doors	Anchor,Century,Sheeji,Kalpataru
19	Aluminium Sections	Jindal,Indal,Hindalco,Bhoruka,Hydro Aluminium Extrusion
20	Hardware	Dorset,Magnum
21	Glass	Saint Gobain,Asahi,,Pikington,Guardian Glass
22	Paints & Polish	Asain, Kensai-Nerolac, Berger,Unite,Spectrum
23	Wooden Fire Door	Navaire, Sukri
24	ACP	Alucobond/ Eurobond/Alu Décor/ Alstone/ Alstrong

*** Raw material source to be approved by the Engineer-in-charge/Consultant.**

Note: - In case of shortage or scarcity or non availability of material from above mentioned manufacturers, Engineer-in-charge/Consultant may approve the fresh / new manufacturers after the testing of material from approved lab or IIIrd Party Agency

TECHNICAL SPECIFICATIONS FOR ELECTRICAL WORKS

GENERAL:

1.01 The electrical installation work shall be carried out in accordance with Indian Standard Code of practice for Electrical wiring installation IS: 732-1989 and IS:2274-1963. It shall also be in conformity with the current Indian Electricity rules and regulations and requirements of the Local Electricity supply authority and fire insurance regulation.

Wherever these specifications calls for a higher standard of material and or workmanship than those required by any of the above mentions regulations and specification then the specification here under shall take precedence over the said regulations and standards.

1.02 **SCOPE OF WORK:**

The scope of work shall cover the following Electrical work.

❖ The Items / Activities covered under internal and external Electrical works shall include the following conditions:

i) Meter Board, Main Distribution Boards and Distributions Boards. Switch Fuse Unit/MCB/ Provision for lifts and other equipment etc. complete in all respect.

ii) Cables from Meter board to Main Distribution Board. Sub main wiring from Main/Sub Distribution Boards to various final Distribution Boards. Power wiring for equipment etc. complete in all respects.

iii) Point wiring of all lights points, Ceiling fan points, exhaust fan points, cabin fan points, light plug points, general power points, modular plug & socket, outlet points etc. including supply and fixing of light & power accessories etc. complete in all respects.

iv) Receiving and fixing of light fixtures, and fans as per the instruction of Client / Architect.

v) Telephone cabling with telephone cable from each outlet to the Tag block and & sub tag blocks, telephone outlets incoming MS pipes etc. complete in all respect.

vi) RCC/GI pipes for cables, manholes, cable tray and other items required to complete with electrical installation work in all respects.

vii) Earthing of electrical installation complete in all respects.

viii) Supply and fixing of DG Set 125 KVA with AMF Panel complete in all respect.

ix.) Scope of work shall include supply installation, testing and commissioning of complete electrical installation as described above.

1.03 STANDARDS AND REGULATIONS:

All equipments, switchgear, cables and other items of work shall conform to Indian Standard specifications. The installation shall conform in all respects to Indian Standards Code of Practice for Electrical wiring installation IS : 732- 1989. It shall also be in conformity with the current Indian Electricity Rules and the Regulations and requirements of the Local Electric Supply Authority, Local laws/by laws in so far as these become applicable to the installation. Wherever these specifications call for a higher standard of materials and /or workmanship than those required by any of the above regulations, these specifications shall take precedence over the said regulations and standard. In general, the materials, equipment and workmanship shall conform to the following Indian Standards, unless otherwise called for.

- XLPE insulated cables — IS : 7098 Part-I & II 1988/1985
- Marking and arrangements for Switchgear:
- Bus bars, main connection and auxiliary wiring. — IS : 375 - 1963
- Specifications for normal duty air break switches — IS : 13947-1993
- and composite units for air break switches and exceeding 1000 volts. — (Part-I to V)fuses for voltage not
- Specification for low Voltage Switchgear and Control gear Assemblies — IS : 8623 -1993 (Part-I to III)
- Specifications for enclosed distribution — IS : 2675 - 1983
- Installation and maintenance of Switchgear — IS : 10118-1982 (Part-I to IV)
- HRC Fuses — IS : 9224 -1979
- Specification for PVC conduits for electrical wiring. — IS: 9537 -1981
- Specifications for accessories for PVC conduits for electrical wiring. IS : 419
- 3 Pin Plugs and Socket Outlets — IS : 1293 -1988

• General & safety requirements for electric light fittings.	IS : 1913 -1978
• Electric ceiling fans and regulators	IS : 374 -1979
• Code of practice for earthing	IS : 3043 -1987
• Current transformers	IS : 2705 -1992 (Part-I)
• Shut capacitors for power system	IS : 2834 -2986

Inspection and Approval of the Work by Local Authority: On completion of this work, the contractor shall obtain and deliver to the Client all the certificates of inspection and approval by the electrical inspectorate as required. The Client shall have access to the manufacturer's premises for inspection of any item of the tender for which contractor has to make arrangement with different manufacturers.

1 **METER BOARD , MAIN DISTRIBUTION BOARDS AND SUB - DISTRIBUTION BOARDS:**

2.01 GENERAL:

Meter boards, Main Distribution Board/Sub Distribution Boards shall be metal clad totally enclosed, rigid, floor mounting, air insulated, and cubicle type for use on 415 volts, 3 phases, and 50 cycle system. Equipment shall be designed for operation in high ambient temperature and high humidity tropical atmospheric conditions.

2.02 STANDARDS:

(A) The equipment shall be designed to conform to the requirements of **:**

i) IS-8623 - Factory Built Assemblies of switchgear and control gear.

ii) IS-4237 -General requirements for switchgear and control gear for voltages not exceeding 1000 volts.

iii) IS-2147 -Degrees of protection provided by enclosures for low voltage Switchgear and Control gear.

iv) IS-375 - Marking and arrangement of bus bars.

(B) Individual equipment housed in the Main & Sub Distribution Board shall conform to the following IS specifications**:**

i) Moulded Case Circuit Breakers - IS 2516 (Parts I & II/Sec 1) - 1977

ii) Fuse Switch and Switch Fuse Units - IS 4064 - 1978

iii) H.R.C. Fuse links - IS 2208-1962 or IS 9224-1979.

iv) Current Transformers - IS 2705

v) Voltage Transformer - IS 3156

vi) Relays - IS 3231
vii) Indicating Instruments - IS 1248
viii) Integrating Instruments - IS 722
ix) Control Switches & Push Buttons - IS 6875
x) Auxiliary Contractors - IS 2959.

2.03 CONSTRUCTIONS:

Main LT Panel , Main Distribution Board/Sub Distribution and Meter Boards shall be metal enclosed, indoor, floor mounted free standing type made up of the required vertical section, which when coupled together shall form continuous dead front Distribution Board. Main Distribution Board/Sub Distribution Board shall be dust and damp protected the degree of protection being no less than IP-45 to IS 2147. All Panels & Main Distribution Board shall be extensible on both sides by the addition of side section after removal of end covers. Main Distribution Board/Sub Distribution Board shall be fabricated with a framed structure with rolled/folded sheet steel channel section of minimum 2mm thickness, doors and covers shall be of minimum 2mm thick sheet steel. Sheet steel shroud and partitions shall be of exterior of Main Distribution Board/Sub Distribution Board shall be smoothly finished, leveled and free from flaws. The corners to be rounded. Front and rear doors to be fitted with dust excluding neoprene gasket with fasteners designed to ensure proper compression of the gaskets. When covers are provided in place of doors, generous overlap shall be ensured between sheet steel surfaces with closely spaced fasteners to preclude the entry of dust.

Following minimum clearances to be maintained after taking into account connecting bolts, clamps etc.:

i) Between Phases - 32 mm
ii) Between Phases and neutral - 26 mm
iii) Between Phases and earth - 26 mm
iv) Between neutral and earth - 26 mm

All insulating materials used in the construction of the equipment shall be of non hygroscopic materials, duly treated to withstand the effect of high humidity, high temperatures, tropical ambient service conditions. Functional units such as fuse switch / switch fuse unit/ moulded case circuit breakers shall be arranged in multi-tier formation. The design of the Main Distribution Board/Sub Distribution Board shall be such that each fuse switch/switch fuse units/MCCB shall be fully compartmentalized.

Insulated barriers shall be provided with a vertical section and between adjacent section to ensure prevention of accidental contact with main busbars and vertical risers during operation, inspection or maintenance of functional units. All doors/covers providing access to live power equipment/circuits shall be provided with tool operated fasteners to prevent unauthorized access, The panel shall be so constructed that the cable alley shall be sufficient

enough to accommodate all the outgoing and incoming cables. For each cable, there shall be separate cable gland plate of detachable type at the bottom and/or top of the panel as required. Gland plate shall be 3mm thick.

2.04 METAL TREATMENT AND FINISHING:

All metal work used in the construction of the main Distribution Board/Sub Distribution Board should have under gone a rigorous metal treatment process as follows:

i) Effective cleaning by hot alkaline degreasing solution followed by cold water rinsing to remove traces of alkaline solution.

ii) Pickling in dilute sulphuric acid to remove oxide scales & rust formation, if any, followed by cold water rinsing to remove traces of acidic solution.

iii) A recognized phosphating process to facilitate durable coating of the paint on the metal surfaces and also to prevent the spread of rusting in the event of the paint film being mechanically damaged. This again, shall be followed by hot water rinsing to remove traces of phosphate solution.

iv) Passivating in de-oxalite solution to retain and augment the effects of phosphating.

v) Drying with compressed air in a dust free atmosphere.

vi) Primer coating with two coats of a highly corrosion resistant primer, applied wet on wet and stove dried under strictly controlled conditions of temperature and time.

vii) A finishing coat of stoving synthetic enamel paint of gray colour of approved colour / or powder coating.

2.05 BUSBARS:

The busbars shall be air insulated and made of high conductivity, high strength aluminium alloy complying with the requirement of grade E-91E of IS-5082.The busbars shall be suitable braced with non hygroscopic SMC supports to provide a through fault withstand capacity of 50KA RMS symmetrical for one second and a peak short circuit withstand capacity of 105KA for Main LT Panel & 50KA RMS symmetrical for one second for Main Distribution boards and other Panels

The neutral as well as the earth bar should be capable of withstanding the above level. Ridges shall be provided on the SMC supports to prevent tracking between adjacent busbars. Large clearances and creepage distances shall be provided on the busbar system to minimize the possibility of fault. The main phase busbars shall have continuous current rating throughout the length of the panel. The cross section of neutral busbars shall be same as that of the phase busbar for busbars of capacity upto 500 Amp., for higher capacities, the neutral busbar shall not be less than half (50%) the cross section of that of the phase busbars. Connections from the main busbars to functional circuits shall be so arranged and supported to withstand without any damage or deformation the thermal and dynamic stresses due to short circuit currents. Busbars shall be colour coded with PVC Sleeves.

The Main Distribution Board/Sub Distribution Board shall be designed that the cables are not directly terminated on the terminals of switch fuse/fuse switch etc. but are terminated on cable termination links. Capacity of aluminium busbars shall be considered as follows:

Sr.No.	Current Rating (Ampere)	Current Carrying Capacity of Al. Bus Bars (Amp. Per sq.mm)
1.	100 Amp – 500 Amp	1.0 Amp./ sq.mm

2.07 MOULDED CASE CIRCUIT BREAKERS:

GENERAL:

Moulded case circuit breakers shall be incorporated in the Main Distribution Board and Sub Distribution Board wherever specified. MCCBS shall be suitable either for single phase AC 230 volts or three phase 415 volts.

The Circuit breaker shall comply with IEC60 947-2 and IS 13947 part 2

The breaking capacity performance certificate shall be available for category A to the above mentioned standards. The test shall be carried out under the breaking performance during operation (Ics) equal to 100 % of the ultimate breaking capacity (Icu),with following minimum services breaking capacity requirements.

The MCCB shall be with Electronic trip unit or with thermal magnetic releases as specified in the BOQ. All circuit breakers shall have a rated operational voltage of 415/500 AC (50 / 60 Hz).

CONSTRUCTIONS:

The MCCB cover and case shall be made of high strength heat treatment and flame retardant thermo setting insulating material. Operating handle shall be quick make/ quick break, trip-free type. The operating handle shall have suitable "ON" "OFF" and "TRIPPED" indicators. Three phase MCCBS shall have common operating handle for simultaneous operation and tripping of all the three phases.

Suitable for extinguishing device shall be provided for each contact. Tripping unit shall be of thermal magnetic or static type provided in each pole and connected by a common trip bar such that tripping of any one pole operates all three poles to open simultaneously. Thermal magnetic or static tripping device shall have IDMT characteristics for sustained over loads and short circuits.

Contacts trips shall be made of suitable are resistant, sintered alloy for long electrical life. Terminals shall be of liberal design with adequate clearance.

CHARACTERISTICS:

The Protection unit shall have variable overload setting from 80 to 100 % of line current . The setting knob should be centrally adjustable from front, MCCB cover need not be opened for carrying out adjustment.

The short circuit setting should be fixed as specified in IEC 60947-2 and IS 13947 part 2.

OPERATION:

If required, the breaker shall be provided with the facility for padlocking and door interlocking.

The Electrical and mechanical endurance of the MCCB should be as defined by IEC 60947-2 standard.

The MCCB shall be equipped with ''Push to trip'' Button in front to test operation and the opening of the poles.

The circuit breaker rating, the '' push to trip'' button, outgoing circuit identification and the contact position indication must be clearly visible and accessible from the front, through the front panel or the door of the switchboard.

THE OPTION:

It shall be possible to combine the earth fault protection Remote indication of circuit breaker trip condition and operational condition (ON/OFF), Auxilary contact, alarm contact to the Circuit breaker.

INSTALLATION:

It should be possible to terminate cable of required size for the defined current carrying capacity. The requisite size should be made available by means of extended terminals in case the direct terminals are not of adequate size. Adequate phase to phase clearance has to be ensures in case of extended terminals.

The circuit breaker should provide the flexibility of terminating line and load from any direction. Phase barrier should be provided as a standard feature.

TESTING:

a) Original test certificate of the MCCB as per Indian Standard (IS) 315-C - 8370 shall be furnished.

b) Pre-commissioning tests on the MV panel incorporating the MCCB shall be done as per standard.

2.09 MEASURING INSTRUMENTS FOR METERING :

GENERAL:

All the meters shall be of digital type. The accuracy of direct reading shall be 1.0 for voltmeter and 1.5 for ammeters. Other type of instruments shall have accuracy of 1.5. The errors due to variation in temperature shall be limited to a minimum. The meter shall be suitable for continuous operation between 10 degree C to +50 degree C. All meters shall be of flush mounting type of 96mm square pattern. The meter shall be enclosed in a dust tight housing. The housing shall be of steel or phenolic mould. The design and manufacture of the meters shall ensure the prevention of fogging of instruments glass. Instruments meters shall be sealed in such a way that access to the measuring element and to the accessories with in the case shall not be possible

without removal of the seal. The meters shall be provided with white dials and black scale markings.

The indications shall be of LED type red in clour and shall have zero position adjustment device which could be operated from outside.

Suitable selector switches shall be provided for all ammeters and voltmeters intended to be used on three phase supply.

The specifications here in after laid down shall also cover all the meters, instrument and protective devices required for the electrical works. The ratings, type and quantity of meters, instruments and protective devices shall be as per the schedule of quantities.

AMMETERS:

The ammeter shall be of Digital type. Ammeters shall be instrument transformer operated, and shall be suitable for 5A secondary of instrument transformer. The scales shall be calibrated to indicate primary current, unless otherwise specified. The ammeters shall be capable of carrying sustained overloads during faults conditions without damage or loss of accuracy.

VOLTMETERS:

The Voltmeter shall be of digital type. The range for 415 volts, 3 phase voltmeter shall be 0 to 500 volts. Suitable selector switch shall be provided for each voltmeter to read voltage between any two lines of the systems. The voltmeter shall be provided with protection fuse of suitable capacity.

CURRENT TRANSFORMERS :

Current transformers shall be in conformity with IS: 2075 (part I, II & III) in all respects. All current transformers used for medium voltage applications shall be OF Cast resin type rated for 1 kv. Current transformers shall have rated primary current, rated burden and class of accuracy as required. However, the rated secondary current shall be 5A unless otherwise specified. The acceptable minimum class of various applications shall be as given below:

Measuring :	Class 1	Protection 08
	Class 5	Protection10

Current transformers shall be capable of withstanding without damage, magnetic and thermal stresses due to short circuit fault of 65KA on medium voltage system. Terminals of the current transformers shall be marked permanently for easy identification of poles. Separate CT shall be provided for measuring instruments and protection relays. Each CT shall be provided with rating plate.

Current transformers shall be mounted such that they are easily accessible for inspection, maintenance and replacement. The wiring for CT's shall be copper conductor, PVC insulated FRLS wires with proper termination lugs and wiring shall be bunched with cable straps and fixed to the panel structure in a neat manner. The Panel builder to be produced the original invoice of the manufacturer of the current Transformers.

MISCELLANEOUS :

Control switches shall be of the heavy duty rotary type with escutcheon plates clearly marked to show the operating position. They shall be semi-flush mounting with only the front plate and operating handle projecting.

Indicating lamps shall be of the filament type of low watt consumption, provided with series resistor where necessary, and with translucent lamps covers. Bulbs & lenses shall be easily replaced from the front.

Push buttons shall be of the momentary contact, push to actuate type fitted with self reset contacts & provided with integral escutcheon plates marked with its functions.

CABLE TERMINATIONS :

Cable entries and terminals shall be provided in the distribution board to suit the number, type and size of aluminum conductor power cables and copper conductor control cable specified.

Provision shall be made for top or bottom entry of cables as required. Generous size of cabling chambers shall be provided with the position of cable gland and terminals such that cables can be easily and safely terminated.

Barriers or shrouds shall be provided to permit safe working at the terminals of one circuit without accidentally touching that of another live circuit.

Cable risers shall be adequately supported to withstand the effects of rated short circuit currents without damage and without causing secondary faults.

CONTROL WIRING :

All control wiring shall be carried out with 1100V grade single core PVC cable conforming to IS:694/ IS 8130 potential standard copper conductors of minimum 1.5sq. mm for potential circuits and 2.5sq.mm for current transformer circuits. Wiring shall be neatly bunched, adequately supported and properly routed to allow for easy access and maintenance. Wiring shall be identified by numbering ferrules at end. All control fuses shall be mounted in front of the panel and shall be easily accessible.

TERMINAL BLOCKS :

Terminal blocks shall be 500Volts grade of the stud type. Insulating barriers shall be provided between adjacent terminals. Terminal blocks shall have a minimum current rating of 10amps and shall be shrouded. Provisions shall be made for label inscriptions.

THE LABELS :

Labels shall be of anodized aluminium, with white engraving on black background. They shall be properly secured with fasteners.

All cables should be Numbering or Tag

TEST AT MANUFACTURES WORK:

All routine tests specified in IS: 8623--1977 shall be carried out and test certificates submitted to the Engineer

2.10 TESTING AND COMMISSIONING:

Commissioning checks and tests shall be included all wiring checks and checking up of connections. Primary/secondary injection tests for the relays adjustment/setting shall be done before commissioning in addition to routine meggar test. Checks and tests shall include the following.

a) Operation checks and lubrication of all moving parts.

b) Interlocking function check.

c) Insulation test: When measured with 500V meggar, the insulation resistance shall not be less than 100 mega ohms.

e) Trip tests & protection gear test.

2 DISTRIBUTION BOARDS :

(1) Distribution Board shall be double door type suitable for flush installation. All distribution boards shall be of three phase (415 Volts) or single phase (240 volts) type with incoming MCB and ELCB as in Schedule of quantities. Distribution boards shall contain plug in or bolted type miniature circuit breaker mounted on busbars. Miniature circuit breakers shall be quick made & quick break type with trip free mechanism. MCB shall have thermal & magnetic short circuit protection. MCB shall conform with is 8828-1978. Neutral busbars shall be provided with the same number of terminals as there are single ways on the board, in addition to the terminals for incoming mains. An earth bar of similar size as the neutral bar shall also be provided. Phase barrier shall be fitted and all live parts shall be screened from the front. Ample clearance shall be provided between all live metal and the earth case and adequate space for all incoming and outgoing cables. A circuit identification card in clear plastic cover shall be provided for each distribution board.

(2) Miniature Circuit Breakers for lighting circuits shall be of "B" curve where as `C' Curve MCB's shall be invariable used for motor loads, halogen lamps fitting, sodium/mercury discharge lamps and for all power circuits and ‘D’ curve for the UPS and computer applications. All miniature circuit breakers shall be of 10KA rated rupturing capacity. The

(3) **EARTH LEAKAGE CIRCUIT BREAKER or RESIDUAL CURRENT CIRCUIT BREAKERS :**

Earth leakage circuit breaker shall be current operated type and of 100mA sensitivity unless otherwise stated. For single phase distribution, ELCB shall be housed within the DB box. For three phase distribution board, either the ELCB shall be housed in the same box or in a separate box of shall be width & depth of D.B box. ELCB box shall be of same finish.

3.01 CONDUIT WIRING SYSTEM :

TYPE AND SIZE OF CONDUIT

(i) All PVC conduit pipes and accessories shall be of suitable material complying with IS: 2509-1973 and IS:3419-1989 for rigid conduits and IS: 9537 (Part 5) 2000 for flexible

conduits. The interior of the conduits shall be free from obstructions. The rigid conduit pipes shall be ISI marked.

(ii) The conduits shall be circular in cross-section. The conduits shall be designated by their nominal outside diameter.

(iii) No PVC conduit less than 20mm in diameter shall be used.

(iv) Wiring capacity

The maximum number of PVC insulated copper conductor cables of 650/1100V grade conforming to IS: 694-1990 that can be drawn in one conduit of various sizes is given in table the Conduit sizes shall be selected accordingly.

3.02 CONDUIT ACCESSORIES

(i) The conduit wiring system shall be complete in all respect including accessories.

(ii) Rigid conduit accessories shall be normally of grip type.

(iii) Flexible conduit accessories shall be of threaded type.

(iv) Bends, couplers etc. shall be solid type in recessed type of works, and may be solid or inspection type as required, in surface type of works.

3.03 INSTALLATION

Common aspects for both recessed and surface conduit works.

(i) The erection of conduits of each circuit shall be completed before the cables are drawn in.

(ii) Conduit joints

(a) All joints shall be sealed/cemented with approved cement. Damaged conduit pipes/fittings shall not be used in the work. Cut ends of conduit pipes shall have neither sharp edges nor any burrs left to avoid damage to the insulation of Conductors while pulling them through such pipes.

(b) The Engineer-in-charge/Consultant with a view to ensuring that the above provision has been carried out, may require that the separate lengths of conduit etc. after they have been prepared shall be submitted for inspection before being fixed.

(iii) Bends in conduit

(a) All bends in the system may be formed either by bending the pipes by an approved method of heating, or by inserting suitable accessories such as bends, elbows or similar fittings, or by fixing non-metallic inspection boxes, whichever is most suitable. Where necessary, solid type fittings shall be used.

(b) Radius of bends in conduit pipes shall not be less than 7.5 cm. No length of conduit shall have more than the equivalent of four quarter bends from outlet to outlet.

(c) Care shall be taken while bending the pipes to ensure that the conduit pipe is not injured, and that the internal diameter is not effectively reduced.

(iv) Outlets

All switches, plugs, fan regulators etc. shall be fitted in flush pattern. The fan regulators can be mounted on the switch box covers, if so stipulated in the tender specifications, or if so directed by the Engineer-in-charge/Consultant.

3.04 RECESSED CONDUIT WORK

(i) Making chase

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

(b) In the case of buildings under construction, the conduits shall be buried in the wall before plastering, and shall be finished neatly after erection of conduit.

(c) In case of exposed brick / rubber masonry work, special care shall be taken to fix the conduit and accessories in position along with the building work.

(ii) Fixing conduits in chase

(a) The conduit pipe shall be fixed by means of staples, J-hooks, or by means of saddles, not more than 60 cm apart or by any other approved means of fixing.

(b) All threaded joints of conduit pipes shall be treated with some approved preservative compound to secure protection against rust.

(iii) Fixing conduits in RCC work

(a) The conduit pipes shall be laid in position and fixed to the steel reinforcement bars by steel binding wires before the concreting is done. The conduit pipes shall be fixed firmly to the steel reinforcement bars to avoid their dislocation during pouring of cement concrete and subsequent tamping of the same.

(b) Fixing of standard bends or elbows shall be avoided as far as practicable, and all curves shall be maintained by bending the conduit pipe itself with a long radius, which will permit easy drawing in of conductors.

(c) Location of inspection / junction boxes in RCC work should be identified by suitable means to avoid unnecessary chipping of the RCC slab subsequently to locate these boxes.

(iv) Fixing inspection boxes

(a) Suitable inspection boxes to the minimum requirement shall be provided to permit inspection and to facilitate replacement of wires, if necessary.

(b) These shall be mounted flush with the wall or ceiling concrete. Minimum 65mm depth junction boxes shall be used in roof slabs and the depth of the boxes in other places shall be as per IS: 2667-1988.

(c) Suitable ventilating holes shall be provided in the inspection box covers.

(v) Fixing switch boxes and accessories.

Switch boxes shall be mounted flush with the wall. All outlets such as switches, socket outlets etc. shall be flush mounting type, unless otherwise specified in the Additional Specifications.

(vi) Fish wire

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

(vii) Bunching of Cables

(a) Cables carrying Direct Current may, if desired, be bunched whatever their polarity, but cables carrying alternating current, if installed in metal conduit shall always be bunched so that the outgoing and return cables are drawn into the same conduit.

(b) Where the distribution is for single phase loads only, conductors for these phases shall be drawn in one conduit.

(c) In case of three phase loads, separate conduits shall be run from the distribution boards to the load points, or outlets as the case may be.

All conduit pipes shall be of PVC HMS type approved gauge confirming to IS: 9537 Part 3 impact resistance with out cracks. The maximum number of PVC insulated 650/1100 volts grade copper conductor cable that can be drawn in PVC conduit of various sizes shall be as per IS code. No conduit less than 20mm in diameter shall be used.

3.05 EARTHING REQUIREMENT

(i) A protective (earth) conductor shall be drawn inside the conduit in all distribution circuits to provide for earthing of non-current carrying metallic parts of the installation. These shall be terminated on the earth terminal in the switch boxes, and/or earth terminal blocks at the DB's.

(ii) Gas or water pipe shall not be used as protective conductors (earth medium).

3.06 <u>OUTLET BOXES & COVERS</u>

The switch box shall be made of metal on all sides except on the front. Boxes shall be hot dip galvanized mild steel. Up to 20 x 30cm size M.S. box shall have wall thickness of 18SWG and MS boxes above 20 X 30cm size shall be of 16SWG. The metallic boxes shall be painted with anti-corrosive paint before erection. Clear depth of the box shall not be less than 60mm. All fitting shall be fitted in flush pattern. Phenolic laminated sheet of approved shade shall be used for switch box covers. These shall be of 3mm thick synthetic phenolic resin bonded laminated sheet as base material and conform to grade P-1 OF IS 2036-1994.

SWITCHES

All switches and sockets are modular type which shall be made of fire retardant, self extinguish poly carbonate plastic, able to withstand the glow wire test at 960 deg. C.

The switches shall confirm IS 3854 :1997, The internal design of terminals and contact shall make the switch capable of high overload conditions, The switch shall be of flush type with silver inlay contact on pure copper. All 5Amp, 13 Amp. and 15Amp switches shall be modular type of 240 volts A.C. grade. All 13 Amp. Switch sockets shall be of universal type. All switches shall be fixed on modular plate . All socket shall fully comply with IS 1393: 1988 specifications. The connector s shall be of phosphor bronze for modular type. All 5 Amp socket shall be 5 pin types. All 15Amp socket shall be 6 pin type suitable for 15/5Amp. All switches, sockets, telephone outlets, TV controlling the lights or fans shall be connected to the phase wire of the circuit. Switches shall be located at 1200mm above finished floor level unless otherwise indicated on drawings.

FLUSH COVER PLATE

All switches, sockets, telephone and TV outlets etc. shall be fixed on 3mm thick phenolic laminated sheet cover unless otherwise called for in drawing or BOQ. Flush cover plate shall be secured to the box with counter sunk brass screws & cup washers.

WALL SOCKET PLATE

All 5 and 15Amp socket outlet shall be modular type 5/6 pin respectively. Each outlet shall have a switch located beside the socket preferable on the same flush cover plate. The earth terminal of the socket shall be connected to the earth wire.

3.07 THE WIRING

All internal wiring shall be carried out with PVC insulated multistranded FR copper wires of 1100 volts grade. The circuit wiring for points shall be carried out in looping in system and no joint shall be allowed in the length of the conductors. Circuit wiring shall be laid in separate conduit originating from distribution board to switch board for light/fan. A light/fan switch board may have more than on circuit but shall have to be of same phase. Looping circuit wiring shall be drawn in same conduit as for point wiring. Each circuit shall have a separate neutral wire. Neutral looping shall be carried out from point to point or in light/fan switch boards. A separate earth wire shall be point wiring green colour wire shall be used for phase and black colour wire for neutral. Circuit wiring shall be carried out with red, yellow or blue colour PVC insulated wire for RYB phase wire respectively and black colour PVC insulated wire for the

neutral wires. Bare copper wire shall be used as dearth continuity conductor and shall be drawn along with other wires. No wire shall be drawn into any conduit until all work of any nature, that may cause injury to wire is completed. Care shall be taken in pulling the wires so that no damage occurs to the insulation of the wire.

Before the wires are drawn into the conduit, the conduits shall be thoroughly cleaned of moisture, dust and dirt.

THE JOINTS

All joints shall be made at main switches, distribution board socket and switch boxes only. No joint shall be made in conduits & junction boxes. Conductors shall be continuous from outlet to outlet.

MAINS AND SUBMAINS

Mains and sub main cable where called for shall be of the rated capacity and approved make. Every main and sub main shall be drawn into an independent adequate size conduit. Adequate size draw boxes shall be provided at convenient locations to facilitate easy drawings of the sub main & main cables. Cost of junction box/drawn box is deemed to be included in the rates of sub main wiring. Three phase sub main shall be provided with two earth wire.

Where mains and sub mains cables are connected to the switchgear, sufficient extra lengths of sub main and mains cable shall be provided to facilitate easy connections and maintenance. For termination of cables crimping type cable socket/lugs shall be provided. Same colour code as for circuit wiring shall be followed.

LOAD BALANCING:

Balancing of circuits in three phase installation shall be planned before the commencement of wiring and shall be strictly adhered to.

COLOUR CODE FOR CIRCUIT & SUBMAIN WIRING

Colour code for circuit & sub main wiring installation shall be Red, Yellow, and Blue for three phases. Black for neutral and yellow/green or green insulated earth wire.

CONDUCTORS SIZE

The wiring for the points shall be done as indicated in the boq and drawing.

TELEPHONE WIRE/CABLES

Separate conduits shall be provided for internal telephone wiring of telephone system commencing from tag block. Each telephone outlet shall be wired with 2 pair telephone cable from the tag block. All telephone wires shall be of 0.61mm dia annealed tinned high conductivity copper conductor PVC insulated & PVC sheathed grey conforming to ITD specification SWS 113 B & C. Multipair PVC insulated cables

laid in conduit shall be provided for connecting various tag blocks. Telephone cables used for external connections shall be armoured. These cable shall be laid directly in ground or in pipe etc. as call for else where.

Following number of 2 pair wires/cables shall be drawn in various sizes of conduits as listed below:

20mm Conduit - Up to 3 cables.

25mm Conduit - More than 3 upto 6 cables.

Maximum number of:PVC INSULATED 1100 V GRADE COPPER CONDUCTOR CABLE CONFORMING TO IS: 694 – 1990

Nominal Cross Sectional area of conductor in sq.mm	**20mm**		**25mm**		**32mm**		**38mm**		**51mm**		**64mm**	
	S	B	S	B	S	B	S	B	S	B	S	B
1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**
1.5	5	4	10	8	18	12	-	-	-	-	-	-
2.5	5	3	8	6	12	10	-	-	-	-	-	-
4	3	2	6	5	10	8	-	-	-	-	-	-
6	2	-	5	4	8	7	-	-	-	-	-	-
10	2	-	4	3	6	5	8	6	-	-	-	-
16	-	-	2	2	3	3	6	5	10	7	12	8
25	-	-	-	-	3	2	5	3	8	6	9	7
35	-	-	-	-	-	-	3	2	6	5	8	6
50	-	-	-	-	-	-	-	-	5	3	6	5
70	-	-	-	-	-	-	-	-	4	3	5	4

NOTES:

1. The above table shows the maximum capacity of conduits for a simultaneous drawing in of cables.
2. The columns headed 'S` apply to runs of conduits which have distance not exceeding 4.25m between draw in boxes and which do not deflect from the straight by an angle

of more than 15 degrees. The columns headed 'B' apply to runs of conduit which deflect from the straight by an angle of more than 15 degrees.

3. Conduit sizes are the nominal external diameters.

3 THE L.T. CABLES:

4.01 GENERAL:

L.T. Cables shall be supplied, inspected, laid tested and commissioned in accordance with drawings specifications, relevant Indian Standards specifications and cable manufacturer's instructions. The cable shall be delivered at site in original drums with manufacturer's name clearly written on the drums. The recommendations of the cable manufacturer with regard to jointing and sealing are strictly followed.

4.02 MATERIALS:

The L.T. Cables shall be XLPE insulated PVC sheathed aluminium conductor armoured cable conforming to IS: 7098 (part-I) with upto date amendments or revision. The cable shall be laid directly in ground, pipes, masonry ducts, cable tray surface of wall etc. as shown on drawings.

4.03 INSPECTIONS:

All cables shall be inspected at site and checked for any damage during transit.

4.04 JOINTS IN CABLES: No joints in the cables are allowed in the middle length of the cable.

4.05 INSTALLATION OF CABLES:

Cable laying work shall be carried out as per CPWD specification.

4.06 LAYING OF CABLES IN THE GROUND:

Cables shall be laid by skilled experienced workmen using adequate rollers to minimize stretching of the cables. The cable drums shall be placed on jacks before unwinding the cable. With great care it shall be unrolled on over wooden rollers placed trenches at intervals is not exceeding 2 meters. Cables shall be laid at depth of 0.6 meters below ground level. A cushion of sand total of 250mm shall at provide both above and below the cable, joint boxes and other accessories. Cable shall not be laid in the same trench or along side a water main. The cable shall be laid in excavated trench over 80mm layer of sand cushion. The relative position of the cables, laid in the same trench shall preserve. At all changes in direction in horizontal and vertical planes, the cables shall be bent smooth with a radius of bend not less than 12 times be provided at both end of cable.

4.07 PROJECTIONS OF CABLE:

The cables shall be protected by bricks laid on the top layer of the sand for the full length of underground cable. Where more than on cables is laid in the same project a minimum of approximately 80mm on either side of the cables. Cable under road crossings and any other places subject to heavy traffic shall be protected by running them through Hume Pipes of suitable size.

4.08 EXCAVATION & BACK FILL:

All excavation and back fill required for the installation of the cables shall be carried out by the contractor in accordance with the drawings and requirements laid down elsewhere. Trenches shall be dug true to line and grades. Back fill for trenches shall be filled in layer not exceed 150mm. Each layer shall be properly rammed and consolidated before laying the next layer.

The contractor shall restore all surface, road ways, side walks, curbs, wall or the works cut by excavation to their original condition to the satisfaction of the Engineer.

4.09 LAYING OF CABLES ON CABLE TRAY& SURFACE OF WALL CEILLING:

Cable shall be laid on purpose made cable try. Cables shall be properly dressed before cable ties/clamps shall be fixed. Wherever cable tray is not proposed, cables shall be fixed on surface of wall or ceiling slab by suitable MS clamps/saddles. Care shall be taken to avoid crossing of cable.

4.10 TESTING OF CABLES

(1) Prior to installation burying of cables, following tests shall be carried out. Insulation test between phases, phase & neutral, phase & earth for each length of cable.

a.) before laying

b.) After laying

c.) After jointing

(2) On completion of cable laying work, the following tests shall be conducted in the presence of the Engineer

a.) Insulation Resistance Test (Sectional and overall).

b.) Continuity Resistance Test.

c.) Earth continuity Test.

All tests shall be carried out in accordance with relevant Indian Standard code of practice and Indian Electricity Rules. The contractor shall provide necessary instruments, equipments and labour for conducting the above tests & shall bear all expenses of conducting such tests.

4 THE CABLE TRAY:

The cable tray shall be fabricated out of slotted/perforated MS sheets as channel sections, single or double bended. The channel sections single or double bended. The channel sections shall be supplied in convenient lengths and assembled at side to the desired lengths. These may be galvanized or painted to the desired lengths. These may be galvanized or painted as specified. Alternatively, where specified, the cable tray may be fabricated by two angle irons of 50mm x 50mm x 6mm as two longitudinal members, with cross bracings between them by 50mm x 5mm flats welded/bolted to the angles at 1m spacing. 2mm thick MS perforated sheet shall be suitable welded/bolted to the base as well as on the two sides.

Typically, the dimensions, fabrication details etc. are shown in CPWD General Specification for Electrical Works - part II-External, 2007.

The Jointing between the sections shall be made with coupler plates of the same material and thickness as the channel section. Two coupler plates, each of minimum 200mm length, shall be bolted on each of the two sides of the channel section with

8mm dia round headed bolts, nuts and washers. In order to maintain proper earth continuity bond, the paint on the contact surfaces between the coupler plates and cable tray shall be scraped and removed before the installation.

The maximum permissible uniformly distributed load for various sizes of cables trays and for different supported span are as per CPWD General Specification of Electrical Work Part II -1994. The sizes shall be specified considering the same.

The width of the cable tray shall be chosen so as to accommodate all the cable in one tier, plus 30 to 50% additional width for future expansion. This additional width shall be minimum 100mm. The overall width of one cable tray shall be limited to 800mm.

Factory fabricated bends, reducers, tee/cross junctions, etc. shall be provided as per good engineering practice. (Details are typically shown in Figure 3). Of CPWD General Specification of Electrical Work Part II - 2007. the radius of bends, junctions etc., shall not be less than the minimum permissible radius of bending of the largest size of cable to be carried by the cable tray.

The cable tray shall be suspended from the ceiling slab with the help of 10mm dia MS rounds or 25mm x 5mm flats at specified spacing as per of CPWD General Specification of Electrical work Part II -2007. Flat type suspenders may be used for channels upto 450mm width bolted to cable trays. Round suspenders shall be threaded and bolted to the cable trays or to independent support angles 50mm x 50mm x 5mm at the bottom end as specified. These shall be grouted to the ceiling slab at the other end through an effective means, as approved by the Engineer, to take the weight of the cable tray with the cables.

The entire tray (except in the case of galvanized type) and the suspenders shall be painted with two coats of red oxide primer paint after removing the dirt and rust, and finished with two coats of spray paint of approved make synthetic enamel paint.

The cable tray shall be bonded to the earth Terminal of the switch bonds at both ends.

The cable trays shall be measured on unit length basis, along the center line of the cable tray, including bends, reducers, tees, cross joints, etc., and paid for accordingly.

5 FIRE DETECTION AND ALARM SYSTEM

6.01 **GENERAL**

The contractor shall supply and install the Fire Detection & Alarm system as per schedule of quantities and as herein specified. The system shall include main fire alarm control panel, Repeater Panel, control panel charger, batteries, heat detectors, smoke detector, manual fire alarm station, fire alarm bells/hooters, response indicators, in-built PA system, wiring and all necessary accessories required to complete fire alarm system installation as per IS: 2189-1988. Equipment like control panel, smoke detector, heat detectors shall be TAC approved.

6.02 **FEATURES**

The system shall be general alarm electrically supervised type activation of manual fire alarm station or any of the automatic alarm initiating devices shall sound the general alarm bells on all floors and shall give indication on the control panel. The signal shall be continuous until the station from which it is originated is restored to normal and a reset button on the control unit is operated.

The system shall be electrically supervised against open and ground on both the stations and signal device wiring. Open and ground in the system shall cause a trouble bell to ring at the fire alarm control panel and a trouble lamp to light. It shall be possible to silence the bell but the lamp shall remain lit until the fault is rectified. In case of power failure the system shall automatically changeover to the battery standby.

6.03 **CONDUITING & WIRING**

Conduiting & Wiring for FDA system shall be carried out in M.S. conduit with FRLS copper conductor PVC insulated wires or armoured cable with copper conductor. Each zone shall be wired with two wire system looping from outlet/detector to detector through monitor modules. Ground floor has been provided with repeater panel and Main fire detection & alarm panel located in fire control Room on in the basement of the building.

6.04 **CONTROL PANEL**

The Main & local fire control panel shall be constructed to sheet steel of red colour, and provided with windows for the alarm and trouble lights. All components shall be of the plug in type, for simple replacement and extension in the future. Control panel shall be wall mounting type conforming to IS 513-1986.

The Main & local fire control panel shall be 8zone / required no. of loops. The Panel shall be Microprocessor based with its own fire detection loop/ zone interface cardfor initiating and indicating devices and should also be networkabe with other repeater panel. The fire alarm panel and repeater panel should be connected through RS 485 interface with standby batteries for 24 hrs and half hours alarm condition . The Panel shall be microprocessor based having its own operating system with 40 x 2 lines LCD display Event logging etc as required, LD display with key pad for operation. And monitoring display required. To display all types of alarm conditions, short, open condition with address and should also indicate time and date . The power input to the Pnael shall be of 230 voils AC. 50 Hz single phase.

The Mimic diagram with various Zones clearly marked and provided with LED.

6.05 **CHARGER AND BATTERY**

Unit shall comprise a ventilated cabinet supplied complete with charger, meters, high rate charge switch and lock and key.

Unit shall be designed for Sealed Maintenance Free Batteries and shall provide these batteries with means for keeping the charge up to the proper level. Cabinet shall be ruggedly constructed of a minimum of 1.63mm sheet (16SWG), primed and then finished in red. A steel divider shall completely separate the cell from the charger controls. Separator strips between

cells shall hold them securely to prevent movement or spillage. SMF batteries shall be provided. The battery backup shall be for minimum 24 hours. Batteries shall be kept on wooden planks.

6.06 **ELECTRONIC HOOTERS**

Hooter shall be electronic solid state speaker type having tone for fire which shall be wailing. Hooter shall operate on 24V having an output of approximately 6 watt. The audible range shall be around 100m under normal condition. Cable for this in our system shall be 2 core. The switching shall be provided on the control panel. The outer enclosure of the speaker is made of MS sheet and shall be suitably oven baked and painted. The speaker shall be 4" heavy magnet type. All hooters shall be on one or more circuits. The hooter shall be compatible with P A system.

Specification

a.	Ambient Temperature.	- minus 25 degree C to plus 80 degree C
b.	Relative humidity.	- Max. 95% RH 30 days/year without condensation.
c.	Sound Intensity at on metre distance	- atleast 90db.
d.	Operating Voltage.	- 24 VDC nominal (16 to 26V)

6.07 **MANUAL ALARM CALL POINT FOR SURROUNDINGS**

The manual call point shall be electrically compatible with the standard range of automatic detectors so that it can be connected directly into a supervised two-wire zone of the manufacturer's standard range of control units. The manual call point shall be of pleasant, streamlined and flat appearance permitting its use as flush and surface mounted unit. The manual call point shall consist of the baseplate, insert and cover. The push button shall have minimum on normally closed plus one normally open contacts. The push button shall not be shrouded and the same shall be projected out from the surface of the MS Box. The whole assembly of push button that shall be enclosed in the 16 SWG MS Box except the front side. The front side shall be sealed with breakable glass cover using neoprene or equivalent gasket. The glass cover shall be fixed in such a way that the actuating push button is kept depressed (with NC contact open) so long as the glass cover is in contact. In case of fire, when the glass cover is broken to give the fire warning the push button shall be released due the spring action hence giving remote fire alarm through the NC contact. The breaking of the glass must release an alarm. all inscriptions, texts and marks must be on the manual, call point front plate, not on the glass, so that the glass can easily be replaced anywhere. The alarm contacts shall be of self-cleaning design to prevent failure after a prolonged period of inactivity in unclean environments. The manual call point shall be designed for fail safe operation.

It shall be possible to test the call point without destroying the seal or removing the cover. The manual call point shall be equipped with a self-holding device to maintain the alarm condition until reset by an authorized person. The complete unit and the push button shall be painted signal Red. The internal surface of the MS enclosure of the box shall painted white colour. The external painting shall be of synthetic enameled paint. Aluminium hammer shall be suspended on a hook fixed to the external MS enclosure by means of a non corrodable aluminium chain of sufficient length and play to facilitate easy breaking of the glass cover.

Manual alarm call point located on the outer walls of the building and/or exposed to weather conditions, shall be weather proof type and satisfying the requirement of IP66.

Specifications :

a.	Operating voltage.	16 to 50 VDC
b.	Max. contact load.	0.1A/1W
c.	Terminal for wire cross-sectional area	0.2 to 1.5sq.mm. (SWG 24 to 15)
d.	Ambient temperature	-25degree C to + 80degree. C. (-13degree.F to + 176degree.F
e.	Relative Humidity	95% RH 30 days/year without condensation.
f.	Housing colour	Red.

6.08 **OPTICAL TYPE SMOKE DETECTORS**

Ionization smoke detectors shall respond to invisible and visible combustion gases. The smoke detectors shall have an inherently stable sensor with built-in automatic compensation for changes in ambient conditions. All electronic circuits must be solid state devices and virtually hermetically sealed to prevent their operation from being impaired by dust, dirt or humidity. All circuitry must be protected against usual electrical transients and electromagnetic interference. Reverse polarity or faulty zone wiring shall not damage the detector. The detector shall have no moving parts or components subject to wear. A built-in optional integration circuit shall allow the suppression of brief deceptive phenomena. The detector shall be designed for fast and simple laboratory cleaning.

The detector shall be inserted into or removed from the base by a simple push-twist mechanism to facilitate exchange for cleaning and maintenance. The manufacturer shall produce and provide test equipment allowing to test and exchange ionization type smoke detectors upto 7m (23ft) above floor level. The detector shall connect to the control unit via a fully supervised two-wire circuit.

Specifications:-

a.	Ambient temperature	-25degree C to + 80degree C (-13degree F to + 176degree F)
b.	Relative humidity	Max. 95% RH 30 days year without condensation.
c.	Ambient air velocity	Max. 10m/sec (33ft/sec) horizontal
d.	Operating Voltage	24 VDC nominal (16 to 26 V)
e.	Protection category (IEC 529)	IP - 43
f.	Quiescent current draw	60uA Max.
g.	Maximum Activity	0.9 micro curies
h.	Sensitivity	Threshold value (y) 0.9 typical

6.09 **HEAT DETECTOR**

Heat detector shall be combined rate of rise and fixed temperature type. Heat detectors shall consist of two independent thermistors, designed to automatically compensate changes in ambient conditions. All electronic circuits must be solid state devices and virtually hermetically sealed to prevent their operation from being impaired by dust, dirt of humidity. All circuitry must be protected against usual electrical transients and protected against usual electrical transients and electromagnetic interference. Reversed polarity or faulty electromagnetic interference. Reversed polarity or faulty zone wiring shall not damage the detector. The detectors shall have no moving parts or components subject to wear. It shall be

possible to test the detector in the field. The response (activation) of a detector shall be clearly visible from the outside by a flashing light of sufficient brightness. The detector shall be installed into the base by a simple push-twist mechanism to facilitate exchange for cleaning and maintenance. The detector shall connect to the control unit via a fully supervised two-wire circuit.

The manufacturer shall produce and provide test equipment allowing to test and exchange rate-of rise/fixed temperature heat detectors up to 7m (23ft) above floor level.

Specifications.

a.	Ambient temperature	-25degree.C to + 70 degree.C. (-13degree.F to + 158 degree.F)
b.	Relative humidity	max. 95% RH. 30 days/year.
c.	Protection Category IEC:	IP43.
d.	Operating voltage.	24 VDC nominal (16 to 26)
e.	Quiescent current draw	150uA max.
f.	Current in alarm stage	100mA max.
g.	Sensitivity	
	Operating fixed temperature	57 degree centigrade + 1.5deg.C.
	Operating Rate of Rise	2 deg. C./minute

6.10 **PLUG-IN BASES**

The smoke & heat detectors shall fit into a common type of standard base. Once a bases has been installed, it shall be possible to insert, remove and exchange different types of detectors by a simple push-twist movement. The standard base shall be equipped with screw less wiring terminals capable of securing wire sizes upto formation and weakening of contact pressure. The standard base shall be supplied with a sealing plate, preventing dirt, dust, condensation or water from the conduit reaching the wire terminals or the detector contact points . All standard bases shall be supplied with a removable dust cover to protect the contact area during installation and construction phase of the building. It must allow the check out and verification of the zone wiring before insertion of any detectors. The standard base shall feature a built-in mechanism which allows mechanical locking of as installed detector head, thus preventing unauthorized removal or tempering while maintaining.

The detector contact points shall be designed to retain the detector safely and to ensure uninterrupted contact also when exposed to continuous sever vibration. All electronic components of base and modules must be solid state and virtually hermetically sealed to prevent their operation from being impaired by dust, dirt or humidity. All circuitry must be protected against usual electrical transients and electromagnetic interference. Reversed polarity or faulty zone wiring shall not damage the detector. The standard base shall allow snap-on insertion of an (optional) electronic module, it shall be possible to turn a standard base part into an individually addressable detector base with its own unique identification address at the control unit. The standard base shall have a built-in alarm indicator which is repeatable by connecting a simple 2 core wire to the base. No changes in the zone wiring shall be required to operate the additional alarm indicator. Removal and insertion of dust covers or detectors shall be feasible by a simple push twist movement, even if the locking device has been activates. Special base assemblies shall be available for use in airducts and aspiration air-sampling system wherever required.

6.11 **RESPONSE INDICATOR**

Wherever Smoke/Heat detectors are installed in rooms which are normally closed it is a practice to install a response indicator outside the room to enable the person concerned to determine the spot of fire. The response indicators consist of two LEDs. Which will lights up when an automatic heat/smoke detector operates, There shall be a top red facie on the top of the two LEDs. The enclosure of the response indicator shall be of aluminium.

6.12 **MONITOR MODULE**

The control monitor module shall be of addressable type for 8 way hooter and for control option analog with suitable MS Junction box . The another Adrressable Monitor module of 8 way to connect conventional detection devices, manual call point, flow switches, supervisory space switches with suitable junction box etc.

7.00 DIESEL GENERATOR SET

The Diesel Generator shall be confirmed to CPCB Norms -2 and submit the same certificate to Engineer in charge/consultant

The Diesel Generator Sets shall consist of AC Alternator of 180 KVA, 0.8 P.F. capacity coupled with diesel engine with all accessories and control such as starting device, lubricating arrangements, speed control, automatic control devices, protection gear, instruments etc. as required and specific here in after. The diesel Generator shall be factory assembled and factory tested completed in all respects.

7.01 **DIESEL ENGINE**

Diesel engine shall be of heavy duty, robust construction, suitable for continues duty. Engine shall be enclosed construction and engine case shall be made of grey iron castings. The cylinder head shall be cast iron and shall accommodate one suction valve, one starting valve, one injection valve and one safety valve etc. Piston shall be of cast aluminium and shall be provided with adequate number of sealing ring and strapping rings . The big and small ends shall be fitted with bearings.

7.02 **ENGINE**

The Diesel Engine shall be naturally aspired air cooled type, four strokes, 4 cylinder direct injection type, air cooled , electric starting , multicylinder diesel engine confirming to BS: 5514/BS:649 with 10% overloading for one hour in any 12 hrs. duration.

Lubrication shall be full pressure by gear type pump with full flow filters with replace element. An oil temperature gauge, strainer and relief valve shall be fitted.

Fuel injection shall be enclosed in line fuel injection pump with diaphragm type fuel lift pump. Full fuel filters with replacement element s shall be fitted and 24 volt solenoid provided.

The speed governing mechanism shall be hydraulic type and should keep correct frequency at all possible operating condition well within the limit.

Coolant shall be circulated by a gear driven centrifugal pump through a radiator cool by a pusher flow fan completed with fan cool and a hand protection guard. Generator set shall air cooled and having radiator and fan.

Starting type shall be push button electric starting type by an axial type starter motor from a 184 volt lead acid battery.

A length of flexible exhaust pipe shall be supplied connected to the exhaust manifold. Silencer and exhaust system shall be part of the installation costs. Silencers shall be domestic type Length of exhaust pipe upto 10 mtrs. above ground level from D.G. room shall be deemed to be included in the rates.

7.03 **ENGINE DETAIL**

Dry type air filters shall be fitted.

Type	Multicylinder diesel.
Method of starting	Electric start
Type of cooling	Radiator
Type of governor	Mechanical Governer

Type of fuel High speed diesel

Type of lubricating oil Heavy duty detergent oil

The above engine shall be equipped with the following :-

a. - Radiator

b. -Fuel Tank suitable for 8 hrs. running with necessary piping and fuel gauge.

c. -Fly wheel of suitable diameter and weight.

d. -Fuel and lubricating oil filter.

e. -Fuel injection equipment.

f. -Air cleaner /filter.

g. -Lubricating oil pump.

h. -Flexible coupling.

j. -Governor Electronic.

k. Batteries and battery charger.

Suitable stop device to stop the engine in case of the controller variable exceed the upper limit (Temperature of cooling water lub. and pressure of lub oil.)

Indicating panel of Engine shall be consist of the following.

i. Cooling water temperature gauge.

ii. Lub. oil pressure gauge .

iii Lub oil temperature gauge.

iv Starting switch with key.

v RPM meter with hour meter.

vi. Battery charging ammeter.

vii Oil service tank with all accessories such as level indicator , man hole ., valve inlet and outlet, air vent , drain plug, mounting pedestals etc.

7.04 **BASE AND MOUNTING**

The DG Set shall be mounted on a MS skid base with necessary reinforcement.

7.05 **MOUNTING**

The set will be mounted on spring loaded cushy - footing pads.

7.06 **PERFORMANCE OF DG SET**

a. **Voltage regulation** : Plus or minus 2.5% from no load to full load and at power factor from 0.8 PF (lag) to unity with 4% speed regulation of the engine.

b. **Voltage wave form**: Wave form deviation shall not be greater than 10% or within NEMA MG 1-22.43.

c. **Telephone influence :** As per NEMA requirement.

d. **Interference level :** For AM/FM Radio and Television Equipment.

7.07 **ALTERNATOR.**

7.07.1 **GENERAL**

Alternator shall be of silent pole , rotating field type and shall be self exciter suitable for 415 volts , 50 Hz, A C 0.8 P.F. and 1500 RPM. The alternator shall be of drip - proof construction. Alternator shall generally confirm to IS : 4722 and BS 2613.

7.07.1 **FRAME**

Frame shall be of cast iron construction, the feet and terminal box mounting being cast integral with the frame. A terminal box (adopter) shall be used if required for proper termination of Cables.

7.07.2 **STATOR CORE** :

Stator core shall be built upto silicon steel lamination compressed hydraulically and rigidly supported by either cast iron or steel end rings. The core shall be designed for minimum reactance, low voltage wave from distortion and maximum efficiency , stator coils shall be of tropicalized mica or leatheriod. End windings shall be taped with fiber glass tape and the complete windings shall be impregnated with fiber glass tape and complete winding shall impregnated with varnish and spray finished with moisture protection varnish. Otherwise 100% epoxy impregnating with an overcoat of resilient insulating material shall be carried out.

7.07.3 **END FRAMES**

The end frames shall be of well ribbed cast iron design. The end frames shall spigotted to the stator frame and secured by easily available set screws. Ventilation openings shall be cast into the vertical and bottom side face which shall be screen protection and drip proof.

7.07.4 **BEARING**

The bearing shall be of heavy duty prelubricated cartridge ball or roller bearings. Single bearing alternators shall have self - align ball on roller bearing. The end frame of the rotor shall be removable from stator without disturbing the bearings.

7.07.5 **ROTOR**

The rotor shaft shall be turned either from a tensile MS bar or from a MS forging. Field coils shall be wound with synthetic enamel covered or varnish bounded end glass cover copper strips of high conductivity. Poles shall be of bolt on type made of sheet steel of high permeability. The insulation between the pole and coil shall comprises of varnished fiber glass cloth backed mica around the body and thick insulating washers on the top and bottom of the coil. Coil shall be impregnated with resin and the complete rotor shall be spray finished with a moisture protection varnish suitable for tropical conditions. However 100% epoxy impregnation and an overcoat of resilient insulating material shall be preferable.

7.07.6 **DAMPER WINDING**

The damper bars of copper brazed to heavy copper and connectors shall be located in a semi closed circular slots situated in the pole faces.

7.07.7 **TYPE**

Alternator shall be brushless.

7.07.8 **COUPLING**

Engine and alternator shall be directly coupled through a sturdy flexible coupling.

7.07.9 **TEMPERATURE RISE**

The alternator shall suitable for temperature rise of 50 degree c above ambient and shall be capable of withstanding 10% over load for one hour continuously in 12 hrs. as per IS 4722.

7.7.10 **EXCITER - VOLTAGE REGULATORS**

The exciter shall be over hung, rotating type without any bearing exciter of static type or semi conductor may be provided. Solid state voltage regulator with all accessories and relays shall be providing for proper voltage regulation.

7.7.11 **BALANCING**

All the rotating part shall be dynamically balanced to ensure smooth vibration free running. of number of on load change over switches.

7.08 **OTHER ANCILLARY EQUIPMENT**

7.08.1 **DAY FUEL TANK**

The engine shall be provided with inbuilt day service fuel tank

7.09 **SPECIFICATION OF MATERIALS**

7.09.1 **EXHAUST SILENCER PIPING**

The exhaust silencer piping system shall be of heavy duty MS pipes confirming to class B. Suitable length of flexible piping shall be used for connecting the exhaust piping to the engine as per the recommendation of the manufacturer. MS screws flanges and bends shall be used as per site requirements. Exhaust pipe inside the building shall be logged with 6 mm dia. asbestos rope and suitably bonded with asbestos cloth.

7.09.2 **OIL PIPING**

Oil piping shall be of MS suitable to withstand the pressure as recommended by manufacturer.

7.09.3 **FOUNDATION**

Foundation shall be casted by the civil contactor.

7.09.6 **24 VOLTS DC BATTERIES AND BATTERY CHARGING EQUIPMENTS**

SMF Batteries of required voltage and Ah for the starting of the DG Set shall be fixed inside the enclosure. The battery charger is in the scope of other agency.

The battery bank shall be provided with the following accessories.

a. Battery stand.

b. Set of connectors with ends take off suitable for connection.

7.09.7 The Vendor shall be submitted the Vibration Level data and the sound level data of the DG Set along with the quotation of the DG Set and after the commissioning of the DG Set.

7.10 SOUND ATTENUATING ACOUSTIC ENCLOSURE

Sound Attenuating Acoustic Enclosure should have pleasant and aesthetical looks and should be able to bring down the noise by 25 decibels when measured at a distance of 1 meter away from the set. The DG set should be supported on a base frame in an MS Sheet enclosure with suitable ducting for air inlet and outlet. The door and enclosure should be given corrosion resistant treatment and painted to be weatherproof and long lasting. Resin bonded Glass / Mineral / Rock wool of high density (greater than 45 Kg / Cu. M) with minimum thickness of 75 mm covered with perforated MS Sheet should be provided and covered with tissue paper. Enclosures should be provided with durable locking system with doors duly gasket with neoprene rubber. Exhaust gases should be taken out from the DG Set by means of MS Pipe and a noise suppressor. Proper care should be taken for engine heat rejection in order to have safe working temperature inside the enclosure by provision of fans etc, as required. The design aspect should ensure free and uninterrupted flow of suction and exhaust air in order that the temperature rise of the enclosure with respect to the ambient is less than 7°C.

7.11 **AUTOMATIC MAIN FAILURE CONTROL PANEL :**

The automatic transfer switch panel shall be totally enclosed dead front pattern. The panel shall be free floor standing type with automatic transfer switch to transfer the load from normal source to diesel generator emergency source. The transfer switch shall mechanically held and electrically operated. The switch shall be interlock to ensure only one of the two possible position - normal or emergency. All main contact shall be protected by arcing contact. The operating transfer time shall not exceed fifteen second .All replaceable contacts, coil, spring control mechanism shall be suitable for front operation and maintenance without disassembly and disconnected the power source. Sensing and control relay shall be continues duty, industrial control grade and confirming to relevant and NEMA standards. The panel

shall be provided with aluminum bus bars of the suitable capacity. AMF Panel shall be provided with bye- pass arrangement by incorporating required changeover switches.

7.12 **OPERATIONS**

a. The normal or mains sources shall be constantly monitored by a main voltage monitor.

b. When main voltage fails or drops below 80% adjustment and selectable of the rated voltage, the automatic control system shall give a starting signal to the generator set.

c. As soon as the diesel generator set reaches its operating speed and attains its operating voltage the load shall be transferred on to the generator set.

d. When the normal supply is return back and the voltage is reaches to 90% of its rated voltage for a minute the switch shall re-transfer the load to the normal source.

e. The automatic control system shall reset itself and start the engine generator set upon the failure of the normal sources.

f. In the event of failure of the diesel generator or set due to faulty starting the normal contactor / switch shall get energized without any time delay on the restoration of the normal source.

g. If the diesel set fails to start and reach its operating speed in 25 seconds in three attempts, the set shall automatically be disconnected and locked in isolated position.

h. A test switch to stimulate a normal source failure shall be provided of routing testing of the transfer switch panel and D.G.Set.

7.13 **PROTECTON, INSTRUMENTATION AND ACCESSORIES.**

The automatic transfer switch panel shall be provided with the following protection gear, instruments and accessories.

7.14 **PROTECTION GEAR**

i Neutral isolation by overlapping contacts.

ii Adjustable time delay relays for transfer and retransfer of loads.

iii Engine start/stop control relays, three attempt start facility and failure to start lockout.

iv Auto/Manual/Test selector switch.

v Push buttons, start./stop /reset/test.

vi Selector switch for engine control on/off.

vii A by pass arrangement in the control panel for isolating the control panel from main supply for carrying out maintenance repair to control panel.

viii A by pass arrangement shall consist of number of on load change over switches.

7.15 **INSTRUMENTATION**

i 1 no. AC voltmeter.

ii 1 no. voltmeter selector switch off/main/load on set.

iii 1 no. AC ammeter with selector switch.

iv 1 no. frequency meter.

v 1 no. KWH meter.

vi 3 nos. CTs of specified ratio and burden.

vii 1 no. signal lamp. 'Load on set'.

viii 1 no. signal lamp. (load on mains).

ix 1 no. signal lamp (set fails to start).

x Audio visual system to indicate abnormalities in the standby system.

7.16 **ACCESSORIES**

i Battery charging equipment and instrument for starting of the engine and control energisation. This shall be Part of AMF panel.

ii Cable alley for incoming and outgoing cable with glands.

iii Removal side panel for easy for access and locking arrangement to prevent tempering.

8.0 DRAWING PROCUREMENT & INSPECTION OF EQUIPMENTS.S

8.01 Based on the drawings and the equipment/scheme finally selected, the contractor shall supply layouts, cable line and conducting drawing etc. required for the satisfactory and complete installation of the total electrical power supply and distribution system as envisaged in the tender.

8.02 **PROCUREMENT & INSPECTION OF EQUIPMENT**

Approved list of makes and vendors are given at Para No. 9.0 the makes of equipment/materials supplied shall be strictly as mentioned therein. For items not specially mentioned, prior approval shall be taken before procurement of the same. All equipments/material supplied shall be brand new and shall be procured directly from the manufacturers, dealers or authorized agents.

Client/Architect shall have access to the manufacturer`s premises for stage inspection/final inspection of any item during its design, manufacturing, assembly and testing. After carrying out the necessary factory tests and routine tests as per IS Standards, a copy of the routine test certificate shall be forwarded along with the call for carrying out the inspection at the manufacturer`s works.

Based on the inspection certificate, Client/Architect reserves the right to carry out the inspection at a mutually agreed date and/or give inspection waiver. A minimum of two weeks will be needed after receipt of complete shop inspection report and other details to depute our inspector for inspection.

9.0 THE LIST OF APPROVED MAKES AND SPECILAISED AGENCY

1	Copper wire FRLS	Havells/KEI/Finolex/Skytone
2	Steel conduit / PVC conduit	BEC/Steel Kraft/NIC/AKG
3	Modular Switches/ Sockets	Legrand(Arteor)/Crabtree(Athena) or Equivalent model ofM.k.
4	GI Box (for switches)	Legrand(Arteor)/Crabtree(Athena) or Equivalent model ofM.k.
5	MCB/MCCB/ MCB DB/ Industrial Socket/ Encloser	L&T/ABB/Schneider/Havells/ Legrand
6	Voltmeter & Ammeter	L&T/ABB
7	Current Transformer	Kappa/A.E./Pragati
8	Indication Lamp	L&T/Telemechnique
9	XLPE aluminum armoured cable	Havells/Polycab/R.R. Cable
10	LED lights & fittings/Bulk Head light	Havells/ Philips/Wipro
11	Fan/ regulator	Usha/ Bajaj
12	Anchor fastener (plated) 4"	Hiltop
13	Main LT Panel / M.V. Cubicles Boards	L&T/Scheneider/ Tricolite/ Madhu Electrical/Advance Control/Rajeev Associates
14	Ammeters, Voltmeters, CT's	Enercon / AE / IMP
15	Exhaust fans	Havells / Crompton / Kaitan
16	Motor	Siemens / ABB / Kirloskar / Crompton
17	Diesel Engine (D.G. set)	Shudhir Cummins/Kirlosker/Jackson
18	Pipes	Jindal Hissar / Tata
19	Forged steel fittings	Ture Forge/V.S. Forge
20	Fire Hose	Firechief / Newage /Superex
21	Sluice & Non-Return Valves	Kirloskar/Zoloto/Leader/Audco
22	Terrace Pumps (Electric and Diesel Driven)	Kirloskar / KSB / M&P
23	Pumping Set (fire fighting)	Kirloskar / KSB / M&P
24	Butterfly Valves	Audco / Crescent / Fouress
25	Gunmetal Valves/ Sluice Valves/Non returns Valve	Audco / Leader/Fouress
26	Single Headed Hydrant Valves/Four Way Fire Brigade Inlet	Minimax / New age / Steelage / Tyco/Kirloskar
27	Branch Pipe	New age / Steelage / Minimax
28	Pressure Gauges	Manometer / H Guru / GIC / AN Instrument
29	Pressure Switch	Indfoss / Switcher / Vexma Trafag
30	Fire Hose Pipes	Padmini/Jyoti/R.R.L Hose
31	First aid Hose Reel	Newage / Minimax / Vijay
32	Rubber Pipe for Hose Reel	Steelage / Dunlop/ Newage

33	Starters	Group Schneider / L&T / SIEMENS
34	Flow Switches	TRAC / Levecon / System sensor
35	Fire Extinguishers	Minimax / Excel / Newage/ Vijay/ Cease fire / Superax / Safex
36	Response Indicator	Minimax / Agni/ Ducks Electronics.
37	Exit Signs	Hilite / Legrand
38	Smoke Detector	System Sensor /Ducks Electronics.
39	Sprinkler Heads	Spraysafe/H.D./TYCO/Newage
40	Fire Door	Pecific fire /Kindle/Navair
41	G.I. Cable tray	Vinus / Slotco
42	Single phasing preventors	L&T/ Siemems
43	Pipe coat material	PYPKOTE/Proofing Co Madras
44	Battery	EXIDE/PRESTOLITE
45	Welding Rods	Advani / Victor
46	Paint	J&N/ ASIAN/ NEROLAC
47	Annunciator panel for sprinkler system	PCD/SAFEWAY/ Ducks Electronics
48	Contactor	L&T/ SIEMENS/GE
49	Thimbles/Ferrules	DOWEL
50	Cable Glands	Commex/Gripwell
51	Measuring Meter	L&T/ SIEMENS/Rishab
52	Protection Relays	ABB/L&T/Schneider
53	Aluminum Bus bars	Hindalco/ Nalco
54	Servo Voltage Stabilizer	A.E./ Skyline
55	Fire Alarm & detection system	Honeywell/Milestone/ Ducks Electronics /Fire Agni
56	Electrical work & Firefighting work for Specialized Agency	Milestone pvt ltd./Sterling Wilson/MEP Contractor & Engineers

SPECIFICATIONS OF INTEGRATED SECURITY SYSTEM

I. **CCTV System:**

System Design And Architecture

CCTV system should be designed such as to cover the strategic locations and sensitive areas of the parking facility for comprehensive surveillance and monitoring from central control room within The parking premises.. High end cameras with Day/Night features to be installed for outdoor and perimeter security application, these cameras shall be IR Compatible so that IR Lamps can be introduced at a later stage to enhance night vision. All Speed domes shall be rugged and shall be weather proof as per specifications. The fixed

dome cameras shall necessarily be of Varifocal / fixed lens as per detailed specifications. Day/Night Cameras with built in zoom lenses shall be provided for select indoor/outdoor locations as per the detailed BOQ. Also the systems should utilize only industry standard protocol.

System should be programmed such that operator's intervention if required shall be minimal and the system should provide features like guard tours, preset positions and the preset positions will be linked to perimeter protection system/intrusion system in future. The DVR's should allow for recording of events both continuous and motion triggered as per requirement and recordings should be able to create evidences and support post event analysis.

All Cameras, DVR and Matrix System must be of the same make

1. <u>Fixed Dome with Varifocal Lens</u>:

1.1 General Requirements

- The product specified shall be a fixed dome, 750 TVL high resolution color camera using a 1/3 inch format interline Super HAD CCD imager (795h x 596v effective pixels) prepackaged in an a dome on a molded PC/Acryl housing, and comes complete with a 4.0~9.0 mm varifocal DC iris lens. The Camera should be CE/FCC Certified.
- The camera specified shall be easily surface mounted on ceilings or walls and provide manually adjustable viewing positions of 360° pan and 65° tilt position. And ground floor camera shall be fixed with M.S bracket C, mount type 2,nos.
- The Camera should work with minimum illumination of 0, lux @ 3o meter F1.2, 30 IRE, AGC
- The cameras shall provide high picture quality through Digital signal processing and real color picture through ATW.
- The cameras shall operate within the voltage range of 12VDC (8~18 V) and require maximum 70mA current drain.

1.2 Electrical Specifications:

- Voltage range: 8 to 18 VDC.

- Composite Video Output: 1.0 Vp-p, 75 ohms.
- Resolution: Horizontal: 750 TVL.
- Backlight compensation: Selectable On/Off through DIP switch.
- Sync: Internal crystal-lock
- Imager: 1/3-inch, interline Super HAD CCD
- Signal to noise ratio: More than 48 dB at AGC off.
- Electronic Shutter: 1/50 to 1/100,000 sec.
- White balance: Automatic

1.3 Mechanical Specifications:

- Connectors: Video Out: BNC. Power: DC Jack type

- Horizontal Adjust Angle: 0°~360°; Vertical Adjust Angle: 0°~60°

1.4 Environmental Specifications:

- Temperature:
  1) Operating: -10°C to +55°C
  2) Storage: -20°C to +70°C
- Humidity: 0% to 90% RH, non-condensing.

2. Day/Night Fixed Camera with Varifocal Lens C/CS Mount in Housing

2.1 General Requirements

- The High-Resolution True Day Night Camera shall include, as a minimum, the following features/functions/specifications and CE/FCC certified:
- High performance, ultra miniature, high-resolution digital low light CCD color camera with 0,lux low light sensitivity in color mode, and 0,lux low light sensitivity in "night" mode.
- The High-Resolution True Day Night Camera shall incorporate a 1/3- inch interline transfer CCD, digital signal processing (DSP), and a minimum of 750 TV lines of resolution utilizing an effective pixel count of no less than 752 (H) x 582 (V) PAL.
- The High-Resolution True Day Night Camera shall provide excellent color performance in low light, down to 0. lux @ f1.2 (50IRE). The camera shall incorporate advanced circuitry allowing for automatic changeover to monochrome, providing monochrome performance in extremely low light down to 0. lux @ f1.2 (50IRE).
- For extreme lighting situations, the camera shall support the use of DC and Video iris lenses, selectable by a switch on the unit.
- The High-Resolution True Day Night Camera shall include a switching 12VDC/24VAC power supply with adjustable linelock (from 0º to 280º) and internal sync mode.
- The High-Resolution True Day Night Camera shall provide digital backlight compensation with six (6) sensing zones to electronically compensate for the background lighting and give detail which would normally be silhouetted. To allow

  the most suitable area to be selected, the user shall have the ability to activate the zones individually, or in any combination of the six zones.
- The High-Resolution True Day Night Camera shall have a signal to noise ratio of 50 dB with the AGC off.
- The High-Resolution True Day Night Camera shall incorporate auto white balance to constantly monitor the light and adjust its color. The following three modes must be available: Auto-White Balance (WB-Auto), Preset White Balance (WB-Push), Manual White Balance (WB-Manual)
- To allow the image to be viewed properly on a standard monitor, the High-Resolution True Day Night Camera's default gamma value must be 0.45.
- The High-Resolution True Day Night Camera shall include a Flickerless mode, allowing the unit to be used in applications with 50Hz fluorescent lighting.
- The High-Resolution True Day Night Camera shall offer a menu system capable of

activating all the features and options available on the camera.

- The High-Resolution True Day Night Camera shall include a movable IR cut filter that blocks IR light at wavelengths longer than 750nm when the filter is in front of the CCD sensor, and allows the IR light to be incident on the CCD when the filter is removed from infront of the CCD.
- The High-Resolution True Day Night Camera shall include wired remote control of the camera via RS485 communication. The RS485 communication shall allow remote control of the functions that are accessible via the OSD Screen Display.

2.2 Mechanical Specifications

The High-Resolution True Day Night Camera must have the following mechanical specifications:

1. Video Output.....BNC connector
2. Power Input..... 3-pin push terminal
3. Auto Iris Output ..... 4-pin standard jack
4. Lens Mount ..... C/CS

2.3 Electrical Power Requirements

The High-Resolution True Day Night Camera must have the following electrical specifications:

1. Voltage (+/-10%) 24VAC/12VDC
2. Power Indicator..... Green LED

2.4 ENVIRONMENTAL CONDITIONS

The High-Resolution True Day Night Camera shall be designed to meet the following environmental conditions:

1. Operating Temperature ..... 14° to 122° F (-10° to 50° C)
2. Operating Humidity .....<85%
3. Storage Temperature..... -4° to 140° F (-20° to 60° C)
4. Emissions ..... FCC: Part 15, Class A

2.5 Lens:

- Focal Length (mm) : 5 ~ 50 (10x)
- Iris Range : F1.6 ~ T360 (Equivalent to F360)
- Angle of View (H X V) 1/3” WIDE
  : 51˚17’ X 39˚36’ TELE :
  5˚30’ X 4˚07’
- Focusing Range (From Front Of Lens) (m) : ∞ ~ 0.3
- Back Focal Distance (In Air) (mm) : 7.52 (W) - 7.46 (T)
- Mount : CS
- When power is turned off, iris will automatically be closed.

2.6 Housing:

The Environmental Camera Housing shall include, as a minimum, the following features/ functions/ specifications:

- The Environmental Camera Housing shall incorporate a side-hinged lid to provide easy access to the camera and lens for trouble-free installation and servicing.
- The Environmental Camera Housing shall be constructed from light gray epoxy powder coated die-cast, extruded, and sheet aluminum to provide an excellent barrier against outdoor environments.
- The Environmental Camera Housing shall be totally protected from dust and strong jets of water, and must have an International Standards IP Protection Classification of sixty- six (IP66).
- The Environmental Camera Housing shall utilize three (3) weatherproof cable entry glands on the rear of the housing to allow for easy installation of power and video cables.
- The Environmental Camera Housing manufacturer shall offer the housing with factory installed sunshield, heater, and blower and prepackaged with a wall mount.
- The Environmental Camera Housing shall have a removable camera sled that can be secured along any position in the housing.
- The Environmental Camera Housing shall have the following electrical specifications:
    1. Input Voltage.....24VAC
    2. Power:
        a. Housing .....Camera power b. Heater.....20 watts
        c. Blower.....3.4 watts
- Operating Temperature: Housing.....-4° to 140°F (-20° to 60°C)

3. <u>Speed Dome Camera 25x</u>

3.1 GENERAL REQUIREMENTS

- The product specified shall be a high speed domed camera system available in pendant or suspended ceiling mounted versions designed for indoor and outdoor surveillance applications. The camera system consists of an integrated Super HAD

  color CCD camera with a 1/4-inch imager and a 25X (Color, F=1.6 to 3.7, 3.8 mm to 95 mm) auto-iris, auto-focus zoom lens; a variable/high speed, 360(pan/tilt unit; and an intelligent, integral receiver/driver with RS485/422. Camera should be CE/FCC certified.
- The camera shall have built-in multi protocol for easy interface with DVR or Matrix switcher systems. It should also support selectable cameras address at least up to 999.
- The camera shall be compatible with Switcher/Controller variable speed keyboard.
- The camera shall be equipped with an 25x optical zoom lens and 10x digital zoom facility.
- The camera shall allow the storage of up to 240 preset scenes with each preset programmable for 16 character titles. Eight (8) guard tours shall be available to

consecutively display each of the preset scenes for a programmed dwell time. Also a facility of storing 4 user control patterns in the memory.

- The camera shall Alarm inputs facility to interface with external devices etc as per the application. There should be minimum 8 alarm inputs and 2 alarm programmable outputs.

3.2 Camera Specifications

- Imager: 1/4 inch Super HAD color CCD
  (PAL: 752H x 582V)
- Horizontal Resolution: 750 TVL
- Lens: 25x optical zoom with auto focus (F=1.6 to 3.7, 3.8 mm to 95 mm)
  Digital Zoom: 10x

3.3 Electrical Specifications

- Power: 18~30 VAC, 24 VAC Normal, 850mA, Built-in power line surge circuit
- Video output: 1.0Vp-p ± 0.1Vp-p, 75 ohms.
- Sensitivity: 1.0 lx (Color/day), 0.1 lx (B&W/Night) and 0.01 lx (Digital Slow Shutter)
- Signal to Noise Ratio: Greater than 48 dB.

3.4 Mechanical Specifications

- Pan: Turbo speed 360°/sec; 01(~90(/sec variable speed pan;
- Tilt: Degree 0(~180(, Speed 0.1(~90(/sec according to zoom ratio
- Pre-position speed: 380(/sec.

3.5 Environmental Specifications

- Humidity: Under 90% RH non-condensing.
- Operating temperature: Indoor: 0(C to +50(C;
- Storage temperature: -20(C to +60(C

4. <u>Vandal Proof Fixed IR Dome Camera</u>

- Vandal Proof Dome Camera
- High resolution 750 TV Lines
- 1/3” IT color SONY super HAD CCD
- 0 lx with IR Lamp on
- Camera picture mode change with built-in CDS sensor
- Real color picture through ATW
- Signal to Noise ratio : more than 48dB
- Automatic Back Light Compensation
- 8 step Shutter speed control
- Video Out : Composite(1.0Vp-p), 75 Ω
- Picture Elements: PAL : 795(H) x 596(V)
- Horizontal Resolution : 750 TV Lines
- Minimum Illumination : 0 lx, IR Lamp On
- Electronic Shutter : PAL : 1/50 ~ 1/100k
- Signal-to-Noise Ratio : More than 48dB (AGC Off)

- AGC(Automatic Gain Control) : ON / OFF selectable
- White Balance: Auto (Dip switch Select Auto/Manual)
- BLC: ON / OFF selectable
- Connector : Power input : Jack type; Video Out : BNC
- Operating Temperature : -10°C to 50°C
- Storage Temperature : -20°C to 70°C
- Humidity : Under 80% RH (non-condensing)
- Certification FCC, CE

5. **Fixed Dome Camera**

5.1 Key Features:

- 1/3" Color CCD
- Minimum illumination 0. lx
- High resolution 750 TV Lines
- High resolution picture quality through Digital Signal Processing
- High S/N ratio, more than 48dB
- True Color Reproduction through Various White Balance
- Mirror Mode

5.2 Specifications:

- Pick-up Device .....1/3" Color CCD, 410k Pixels
- Effective Pixels ..... 752(H) x 582(V)
- Television System ..... PAL, 750 TV Lines, 2:1 Interlace
- Sync System .....Internal
- Horizontal Resolution .....750 TV Lines
- Minimum Illumination .....0.5 lx (F1.2, 30IRE, AGC On)
- Shutter Speed ..... 1/50 ~ 1/100k
- S/N Ratio .....More than 48dB (AGC off)
- AGC .....On
- White Balance .....Auto

- BLC .....ON / OFF
- Mirror .....ON / OFF
- Video Output .....Composite (1.0Vp_p),75
- Power Source DC12V
- Operating Temperature .....-10°C ~ +55°C
- Operating Humidity .....90% RH (non-condensing)
- Storage Temperature .....-20°C ~ +70°C
- Lens Mount .....3.6 mm
- Horizontal Adjust Angle .....0°~ 360°
- Vertical Adjust Angle .....0°~ 65°
- Certification .....FCC, CE

MANUFACTURER/ ACCEPTABLE SUPLEPLIER FOR C.C.T.V.SYSTEM

1. CAMARA AND DVR - BOSHE, SONY, SAMSUNG, GE.
2. P.C & PROSSESOR FOR CAMERA IMEGEIN – DEL, H.P, AND LENOVO.
3. WIRE AND CABLES -- HAVELS, FINOLEX, KEI, POLYCAB.
4. PVC AND M.S CONDUIT-- AKG, BEC, POLYPAC.

Lighting Arrestor ESE TYPE Lightning Protection System Specification

1.1 Scope of Work

The work to be done under this section comprises the supply & installation necessary for the complete installation of the lightning protection system.

The design of the components shall be traceable to field research, laboratory testing, fundamental analysis, and statistical levels of the lightning event.

The lightning protection system should complies in accordance with NFC 17-102 & UNE 21 186 standard and shall be installed strictly to the manufacturer's instructions.

The advance lightning protection system shall include components as follows:

- ESE Air Terminal
- Mast with Accessories (Mechanical Supports)
- Down Conductors
- Lightning Strike Counter
- Maintenance free chemical gel earthing system

The LPS shall be designed by a company engaged in the manufacturing and development of advanced lightning system components, of types, sizes and ratings as shown.

The advanced lightning protection system shall be installed strictly to the manufacturer's instructions.

1.2 Standards

(i) Complete installation shall be engineered and constructed in accordance with the latest revision of the following:

- NFC 17 102
- UNE 21 186

1.3 ESE Air Terminal

The Terrastreamer ESE air terminal shall be of the type that responds dynamically to the appearance of a lightning downleader by creating free electrons between outer floating four panels and an earthed central finial rod. The lightning air terminal shall be configured as a spheroid which is comprised of separate electrically isolated panels surrounding an earthed central finial. The unit shall detect the lightning when it approaches and emit the streamer within few micro seconds. ESE air Terminals shall be manufactured as per NFC 17-102 standard.

The air terminal should work under Early Streamer Emission (ESE) Technology and the attractive radius of the air termination shall be traceable to known and acceptable lightning research and statistics. The ESE air terminal should have no moving parts, no electronic circuits and will have no dependence on external power supply or batteries. The ESE air terminal shall not have any solar panels, no inbuilt batteries, no usage of any degradable ceramics like transducers, etc.

The ESE air terminal should deliver a unique gain time in efficiency, anticipating the natural formation of an upward leader. The ESE air terminal generates a leader that propagates rapidly to capture the Lightning stroke and conduct it towards the ground.

The protective zone provided by the air termination shall be such that it becomes the

preferred strike point for all discharges exceeding a peak amplitude return strike current of "X" kA according to the statistical level "Y". The design shall take account of upward leader competing projections on the structure.

Strike Current (X)	**Level of Protection (Y)**	**Exceedance Probability**
2.9 KA	Protection Level I - Very High	99%
5.4 KA	Protection Level II - High	97%
10.1 KA	Protection Level III - Medium	91%
15.7 KA	Protection Level IV - Standard	84%

The materials of the air termination shall be non –corroding in normal atmosphere. The height of the air terminal support mast should be minimum 2 meters and the height will be increase as per the coverage design.

The support shall be securely installed and guy wires shall be used where necessary to enable the air termination and mast system to withstand maximum locally recorded wind velocities.

1.4 AIR TERMINATION SUPPORT (MAST)

The air termination shall be fixed at the top of a GI or FRP elevation pole so as to be at least 2 meters above the top of the structure to be protected. The elevation pole should have a minimum diameter of 35 mm to 50 mm with a thread at the top to fix the unit.

The support shall be securely bolted to other mast materials with guy wires used where necessary to enable the air termination and mast system to withstand maximum locally recorded wind velocities.

1.5 DOWN CONDUCTOR

The down conductor for the lightning arrester shall be of 70 sq.mm PVC insulated flexible copper cable or 25 x 3 mm (copper/G.I) strip along with the fixing accessories.

1.6 LIGHTNING STRIKE COUNTER

Each protection system shall be supplied with Lightning strike counter. The lightning strike counter shall be of mechanical type and non-resettable with 7 digits. LCD screen is not permitted; because the display depends upon the battery and battery life is not reliable.

The counter shall have a register that activates one count for every discharge where the peak current exceeds 3000A at the 8/20 micro second waveform and a maximum of 220 KA.

The lightning strike counter shall be installed to the manufacturer's instructions in a readily accessible manner (always 2 mtrs above the ground) so that reading can be taken at regular intervals.

1.7 EARTHING

The lightning arrester grounding system reading shall not exceed 10 ohms static impedance except with prior approval by the specifying engineer or manufacturer of the lightning protection system. The backfill compound should be tested & certified from any laboratory for the resistivity of the material parameter of less than 0.2 ohm-mtr.

As per the international standards, earthing system is a preferred design for lightning protection. The earth electrode shall be of UL listed 10 feet long 17 mm dia 250 microns copper bonded steel rod.

The electrode shall be surrounded by Terrafill ground enhancement backfill compound. The grounding minerals shall contain a compound with a base electrolyte when mixed with other compounds produces an earth gel which provides good earthing gel.

The earth pit shall be suitable covered with the man hole chamber for the testing purpose. Polyplastic earth pit chamber with cover – shall be weather proof heavy duty environment friendly with cover.

TECHNICAL SPECIFICATIONS FOR FIRE SUPPRESSION WORKS.

Section F1. General Instructions

F1.1 Fire suppression works specified in the tender have to be executed in accordance with:

F1.1.1 The rules and regulations of Local Fire Authority as per the statutory regulations applicable for obtaining the occupation certificate from the Local Development / Fire Authority.

F1.1.2 The contractor has also to ensure compliance of the Rules of the Tariff Advisory Committee (TAC) of the Insurance Association of India, as amended up to date to enable the Project Managers to apply for getting the maximum rebate on insurance premium for the building. Contractors responsibility for compliance will be only with respect to the items of work put to tender. He will prepare and submit a set of drawings and calculations and such other information as required for making the application. He will also assist the Project Managers in providing all technical clarifications, corrections to drawings and calculations as required by the TAC.

F1.1.3 Applicable norms laid down by the National Building Code of Bureau of Indian Standards (B.I.S.) shall be followed as applicable.

F1.1.4 The codes of the National Fire Protection Association of USA (N.F.P.A.) shall used as a general guide for good engineering practice, design and workmanship norms. No certificate of compliance to NFPA codes will be required.

F1.1.5 All materials used in the works shall have Bureau of Indian Standards valid certification stamped, marked or cast on the material in an acceptable and approved manner.

F1.1.6 It is the contractor's responsibility to ensure the competence of design to meet the above requirements.

F1.1.7 Drawings issued with the tenders are schematic and indicate the concept. Contractor shall make his shop drawings on basis of Architectural and Interior design drawings issued by the Engineer-in-charge /Consultant Work will be executed only as per approved shop drawings.

F1.1.8 Quantities in the tender document are approximate worked out on the tender drawing issued.

F1.1.9 Contractors are invited to highlight any aspects of the contract document that may need revision or reconsideration before the work is started. He must furnish a details of any variations in the specifications or the quantities that may be necessary for him to comply with the Code and statutory requirements. These may be identified and approval of the Project managers taken before the start of the work.

F1.1.10 Contractors shall furnish detailed Shop drawings, hydraulic and other design calculations for submission and approval of the Local Fire Authority and for Insurance Companies

F1.1.11 It is the sole responsibility of the contractor to get the approval of the Local Fire Authority for the work done by him and nothing extra shall be payable including the official and other charges.

F1.2 System Design

Fire suppression system for the building is based on the concept of "total protection" by the wet riser hydrant and sprinkler system for the entire premises with excepted areas identified on the drawings or as instructed by the Project Managers.

F1.3 Water Storage & Pump House

F1.3.1 A static underground RCC water storage tank having gross water storage capacity of 120 cum will be provided. The tank will be provided with manholes, inserts, puddle flanges, ladders inside and outside the tanks.

F1.3.2 One over head water storage tank of 75 cum capacity as a secondary water source for the sprinkler system /hydrant system will be provided on the terrace.

F1.3.3 The pump house and U.G. water tanks are located in the first basement so as to provide net positive suction to all pumps. Test lines from pumps shall discharge back into the fire tank to conserve water.

F1.3.4 Configuration and operating conditions of pumps are given in the Specifications.

F1.4 Wet Riser Hydrant System

F1.4.1 The building will be provided with a wet riser system. Hydrants are fed from a 150 mm dia M.S. pipe running in first basement.

F1.4.2 External fire hydrants with butterfly isolation valves will be provided on the ring main. Hydrants shall be located at least 2 m away from the building.

Internal wet risers for the building shall be connected to the ring main with an non return valve and a three way fire brigade inlet connection with isolation butterfly valve for each wet riser connection.

F1.4.3 Hydrant stations and cabinets shall be provided at all designated locations inside and along with the external hydrants. The hydrant stations shall be located in a MS steel fire cabinets as per drawings and will contain all items described in the specifications.

F1.5 Sprinkler System

F1.5.1 A separate and independent riser for sprinkler shall be provided as shown on the drawings. The system will be divided in several zones with their own installation valves, located in the basement or near the fire pump room.

F1.5.2 The entire building is protected with automatic sprinkler system with permitted exceptions e.g. electrical switch rooms, power transformers and D.G. rooms plant rooms as identified.

F1.5.3 Types of sprinklers to be used shall be as given in specifications, BOQ and approved by the Project Managers

F1.6 Pumping System

F1.6.1 The pumping system shall provide the water supply and pressure to the wet riser fire and sprinkler mains. Diesel Engine will be a common stand by.

F1.6.2 Provide a full bore test valve on the by pass line with rate of flow meter on the common pump header to discharge in the water tank. Also provide an isolation valve on headers outlet to each circuit to enable pressure setting and testing of pumps.

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End of Section F1. General Instructions

Section F2. Fire Hydrant & Automatic Sprinkler System

F2.1 Scope of work

F2.1.1 Wet riser fire hydrant system (internal & external)

F2.1.2 Automatic sprinkler system

F2.1.3 Fire hydrant & sprinkler pumps.

F2.1.4 Valves, suction and delivery connections and headers.

F2.1.5 Hand appliances.

F2.1.6 Pipe protection, painting, sleeves & minor civil works other than specifically mentioned in the tender.

F2.1.7 Electrical installations.

F2.1.8 Specialised protection as specified.

F2.1.9 Testing and commissioning.

F2.2 General Requirements

F2.2.1 All materials shall be new of the best quality conforming to the specifications and subject to the approval of the Project Managers.

F2.2.2 Pipes and fittings shall be fixed truly vertical, horizontal or in slopes as required in a neat

workmanlike manner.

F2.2.3 Pipes shall be fixed in a manner as to provide easy accessibility for repair and maintenance and shall not cause obstruction in shafts, passages etc.

F2.2.4 Pipes shall be securely fixed to walls, and ceilings by suitable clamps at intervals specified. Only approved type of anchor fasteners shall be used for RCC ceilings and walls.

F2.2.5 Valves and other appurtenances shall be so located that they are easily accessible for operations, repairs and maintenance.

F2.3 Pipes

F2.3.1 All pipes within and outside the building in exposed locations and shafts including connections buried under floor shall be M.S. Pipes as follows:

F2.3.1 Pipes 150 mm dia and below IS: 1239 Medium Class

F2.3.2 Pipe 200 mm dia and above IS 3589 of thickness specified.

F2.4 Pipe Fittings.

F2.4.1 Pipes and fittings means tees, elbows, couplings, flanges, reducers etc. And all such connecting devices that are need to complete the piping work in its totality.

F2.4.2 Screwed fittings shall be approved type malleable or cast iron with reinforced ring on all edges of the fittings suitable for screwed joints.

F2.4.3 Forged steel fittings of approved type with “V" groove for welded joints.

F2.4.4 Fabricated fittings shall not be permitted for pipe diameters 50 mm and below.

F2.4.5 When used, they shall be fabricated, welded and inspected in workshops under supervision of Project Managers whose welding procedures have been approved by the TAC as per TAC rule 4102 for sprinkler system and applicable to hydrant and sprinkler system. For "T" connections, pipes shall be drilled and reamed. Cutting by gas or electrical welding will not be accepted.

F2.5 Jointing

F2.5.1 Screwed (50 mm dia pipes and below)

Joint for black steel pipes and fittings shall be metal-to-metal thread joints. A small amount of red lead may be used for lubrication and rust prevention. Joints shall not be welded or caulked.

F2.5.2 Welded (65 mm dia and above)

Joints between M.S. and pipes and fittings shall be made with the pipes and fittings having "V" groove and welded with electrical resistance welding in an approved manner. Butt-welded joints are not acceptable. Buried pipes will be subject to X Ray test from an approved agency as per the TAC norms at the cost of contractor.

F2.5.3 Flanges.

Flanged joints shall be provided on :

a) Straight runs not exceeding 30 m on pipelines 80 mm dia and above.

b) Both ends of any fabricated fittings e.g. bends, tees etc. of 65 mm dia or larger diameter.

c) For jointing all types of valves, appurtenances, pumps, connections

With other type of pipes, to water tanks and other places necessary and

required as good for engineering practice.

d) Flanges shall be as per I.S. with appropriate number of G.I. nuts and bolts, 3 mm insertion neoprene gasket complete.

F2.5.4 Unions

Provide approved type of dismountable unions on pipes lines 65 mm and below in similar places as specified for flanges.

F2.6 Excavation

F2.6.1 Excavation for pipe lines shall be in open trenches to levels and grades shown on the drawings or as required at site. Pipe lines shall be buried to a minimum depth of 1.2 meter or as shown on drawings.

F2.6.2 Wherever required contractor shall support all trenches or adjoining structures with adequate timber supports.

F2.6.3 On completion of testing and pipe protection, trenches shall be refilled with excavated earth in 15 cms layers and consolidated.

F2.6.4 Contractor shall dispose off all surplus earth with in a lead of 200 m or as directed by Project Manager.

F2.7 Anchor Thrust Blocks

F2.7.1 Contractor shall provide suitably designed anchor blocks in cement concrete to encounter excess thrust due to water hammer & high pressure.

F2.7.2 Thrust blocks shall be provided at all bends & tees & such other location as determined by the Project Manager.

F2.7.3 Exact location, design, size and mix of the concrete block shall be approved by the Project Manager prior to execution of work.

F2.8 Valves

F2.8.1 Ball Valves

a) Valves 40 mm dia & below shall be heavy type nickel plated Brass body screwed type, with chromium plated brass balls, PTFE Teflon seating and gland packing tested to a hydraulic pressure of 20 kg/sq cm including coupling and gunmetal handle conforming to B.S. 5351 with female screwed ends.

b) All valves shall be approved by the Project Manager before they are allowed to be used on work.

F2.8.2 Butterfly Valves

Butterfly Valves shall be cast iron body and shall be of class P.N. 1.6 tested to 20 kg/cm^2 with following details :-

a) Disc shall be CI heavy duty electrolyses nickel plated abrasion resistant.

b) The shaft be EN-8 Carbon Steel with low friction nylon bearings.

c) The seat shall be drop tight constructed by bonding resilient elastometer inside a rigid backing.

d) Built in flanged rubber seals.

e) Actuator to level operated for valves above ground and T Key operated for valves below ground.

f) Built in flanges for screwed on flanged connections.

Manufacturer's details on fixing and installation will be followed.

F2.8.3 Non Return Valves (NRV)

Where specified non return valve (swing check type) shall be C.I. / MS. Wafer type, suitable for PN-1.6 pressure, EPDM / Nitrile seat, provided through which flow can occur in one direction only. It shall be single door swing check type of best quality.

F2.9 Air Vessel / Air Cushion tank.

F2.9.1 Air cushion tank shall be of size and capacity indicated in schedule of quantities. It shall be provided at the top most point/points and/or in pump house (as specified). The tank shall be complete with 20mm dia. Brass Air Valve (Ball type), Stop Valve (20mm dia), Drain valve (20mm dia) and pressure gauge including 20mm dia. Mild Steel Galvanised pipes and fittings, unions, etc. as required to complete the work as per site conditions.

F2.9.2 Air Cushion tank shall be measured by numbers and shall include Air Valve, Pressure Gauge, Globe Valves for testing and draining, M.S. Clamps, Pipes, Fittings, Tees Elbows Union and all other items required to complete the work.

F2.10 Orifice Flanges

Provide orifice flanges fabricated from 6 mm thick stainless steel plate to reduce pressure on individual hydrants to restrict the operating pressure to 3.5 Kg/sq.cm. and allow a discharge of 560 lpm. The contractor shall submit design of the orifice flanges for approval before installation

F2.11 Drain Valve

Provide 25 mm dia black steel pipe to IS: 1239 (heavy class) with 25 mm Ball valve for draining any water in the system in low pockets.

F2.12 Inspection & testing assembly

Inspection and testing of the sprinkler system shall be done by providing an assembly consisting of gunmetal valves, gunmetal sight glass, bye-pass valve. The drain pipe beyond the valve upto the drainage point shall be measured with the pipe.

F2.13 Pump test assembly

Provide on the main fire sprinkler header a 150 mm dia bye pass valve located in an accessible manner along with a rate of flow rotometer calibrated in lpm and able to read 200 % of the rated pump capacity. The delivery shall be connected to the fire tank.

F2.14 Pressure Gauge

Pressure gauge shall be provided near all connections to hydrant system and isolation valves of sprinkler system and where required. Pressure gauge shall be 100 mm dia gunmetal Bourden type with gunmetal isolation cock, tapping and connecting pipe and nipple. The gauge shall be installed at appropriate level and height for easy readability.

F2.15 Hydrant/valve chambers

F2.15.1 Contractor shall provide suitable brick masonry chambers (wherever required) in cement mortar 1:5 (1 cement: 5 coarse sand) on cement concrete foundations 150 mm thick 1:5:10 mix (1 cement: 5 fine sand: 10 graded stone aggregate 40 mm nominal size) 15 mm thick cement plaster inside and outside finished with a floating coat of neat cement inside with cast iron surface box approved by fire brigade including excavation, back filling complete.

F2.15.2 Valve chambers shall be 60x60 cms. for depths up to 100 cms.

F2.16 Flow switch

F2.16.1 Flow switches shall be provided on sectional mains and branch lines of sprinkler systems where indicated on drawings, or necessary and required and directed by the Project Manager.

F2.16.2 Flow switch should be suitable to actuate for opening of a single sprinkler and shall be suitable for connection to a central annunciation panel.

F2.17 Fire brigade connections

Provide as shown on drawings separate gunmetal 4 way collecting head with four 63 mm instantaneous type inlets with built in check valves and 150 mm dia outlet connected to the fire and sprinkler main. Collecting head shall be installed on a stand post and provided with horizontal C.I. reflux valve and location to be approved by Project Manager. Provide etched gunmetal label plates with 50mm height letter. The plates should be firmly fixed to the FB connection and any support system.

F2.18 Fire hydrants

F2.18.1 External hydrants

a) Contractor shall provide external hydrants. The hydrants shall be controlled by a cast iron butterfly valve installed in underground lockable chambers. Hydrants shall have instantaneous type 63 mm dia outlets. The hydrants shall be single outlet conforming to I.S.5290-1969 with C.I duck foot bend and flanged riser of required height to bring the

hydrant to correct level above ground.

b) Contractor shall provide for each external fire hydrant two numbers of 63 mm dia. 15 m long rubberized perm line hose pipe with gunmetal male and female instantaneous type couplings machine wound with G.I. wire (hose to I.S. 8423 and couplings to I.S. 903 with M.S. certification), gunmetal branch pipe with nozzle to I.S. 903.

F2.18.2 Internal hydrants

a) Contractor shall provide on each landing and other locations as shown on the drawings **two** double headed gunmetal landing valve with 63 mm dia outlet mounted on a common 100 mm inlet (I.S.5290-1969). Landing valve shall have flanged inlet and instantaneous type outlets as shown on the drawings.

b) Instantaneous outlets for fire hydrants shall be of standard pattern approved and suitable for fire brigade hoses.

c) Contractor shall provide for each internal fire hydrant station two numbers of 63 mm dia. 15 m long rubberized fabric linen hose pipes with gunmetal male and female instantaneous type coupling machine wound with G.I. wire (hose to I.S. 636 Type 2 and couplings to I.S. 903 with I.S. Certification), fire hose reel, gunmetal branch pipe with nozzle I.S. 903 and Fire man's axe.

d) Each hose box shall be conspicuously painted with the letters "FIRE HOSE".

F2.19 Fire hose reels

Contractor shall provide standard fire hose reels with 20 mm dia high pressure rubber hose 36.5 m long with gunmetal nozzle and control valve, shut off valve, all mounted on circular hose reel of heavy duty mild steel construction and cast iron brackets. Hose reel shall be connected directly to the wet riser. Hose reel shall conform to IS:884-1969 and rubber hose to IS: 5132.

F2.20 Hose Cabinets

Provide hose cabinets for all internal fire hydrants. Hose cabinets shall be fabricated from 16 gauge M.S. sheet of fully welded construction with hinged double front door partially glazed with locking arrangement, stove enameled fire red paint with "FIRE HOSE" written on it prominently.(Size as given in the Bill of Quantities).

F2.21 Pipe protection

F2.21.1 All pipes above ground and in exposed locations shall be painted with one coat of zinc chromate primer and two or more coats of synthetic enamel paint of approved shade.

F2.21.2 Pipes in chase or buried underground shall be painted with two coats of zinc chromate primer and wrapped with one layer of 4 mm thick PYPCOAT or equivalent multi layer sheet as per standard manufacturer's specifications.

F2.22 Pipe Supports

F2.22.1 All pipe clamps and supports shall be galvanised steel. When fabricated from M.S. steel sections, the supports shall be factory galvanised before use at site. Welding of galvanised clamps and supports will not be permitted.

F2.22.2 Pipes shall be hung by means of expandable anchor fastner of approved make and design (Dash Fastners or equivalent). The hangers and clamps shall be fastened by means of galvanised nuts and bolts. The size/diameter of the anchor fastener and the clamp shall be suitable to carry the weight of water filled pipe and dead load normally accounted.

Pipe Spacing Table

		<---------- Pipe commercial dia. ----- ---------- ---------- ------							
S.No.	**Pipes & Position**	15/20	20/25	32/40	50	75/80	100/110	150/160	200
1	**Vertical**								
1.1	GI /MS	2.4	2.4	3	3.6	4.5	4.5	5.4	5.4
1.2	CI Pipes IS 1729/3989	x	X	<---------- 3 m ----------				----------	------
1.3	CI Heavy Duty IS 1536	x	X	<---------- 3.6 m ----------				----------	------
1.4	uPVC SWR Systems	x	X	0.5	0.7	0.9	0.9	1.0	
1.5	uPVC Water Supply								

1.6	Polybutylene	<--- As per manufacturer's Reccomendations					----------	----------	------
1	**Horizontal**								
1.1	GI /MS	2.0	2.0	2.4	3.0	3.6	4.0	4.5	4.5
1.2	CI Pipes IS 1729/3989			<---------- 3 m ---------->					
		<---------- Pipe commercial dia. ----- ---------- ---------- ------							
S.No.	**Pipes & Position**	15/20	20/25	32/40	50	75/80	100/110	150/160	200
1.3	CI Heavy Duty IS 1536					3.0	3.6	3.6	4.5
1.4	uPVC SWR Systems				1.2	1.8	1.8	1.8	
1.5	uPVC Water Supply								
1.6	Polybutylene	<---------- As per manufacturer's recommendations ---------->							

F2.23 Installation Valve

F2.23.1 Installation valves shall be installed on the sprinkler circuits as shown on the drawings.

F2.23.2 Contractor shall submit his detailed shop drawings showing the exact location, details of installation of the valve and alarm in all its respects.

F2.23.3 Installation valve shall comprise of a 150 mm dia vertical alarm valve complete with 50 mm dia drain and 15mm dia test valve with a provision to install water operated turbine alarm and an electrical alarm bell. A 150 mm dia slim seal butterfly valve shall be provided on up stream of alarm valve, double seated clapper check valves as alarm valve with pressure gauge and orifice assembly and drain pipe with bye pass on check valve to regulate

differential pressure and false alarm, one water operated turbine alarm motor including all accessories necessary and required and as supplied by original equipment manufacturer and required for full and satisfactory performance of the system.

F2.24 Sprinkler Heads

F2.24.1 Sprinkler heads shall be provided at appropriate spacing to cover 9 m^2 per sprinkler head in the basements and 12 m^2 per sprinkler on upper floors. The spacing shall however be in conformity with the drawings and properly co-ordinated with electrical fixtures, ventilation ducts, grills, etc., **The deflector of the sprinkler shall be provided not more than 150 mm from the ceiling**

F2.24.2 Sprinkler heads shall be quartzoid bulb type with a temp. rating of 68deg. C. with gunmetal body fully approved and having current certification of the fire laboratory of the C.B.R.I. Roorkee, Underwriter's laboratory (UL) and under the approved certified list of the Fire Office Committee (FOC) of U.K. or NFPA of USA. Any one of the certification as acceptable to the local fire authorities obtained prior to the procurement and approved and accepted by the Project Manager.

F2.24.3 Sprinkler heads shall be installed in conformity with approved shop drawings and in co-ordination with electrical fixtures, ventilation ducts, cable galleries and other services along the ceiling.

F2.24.4 Following type of sprinklers shall be used:

S.No.	Type of Sprinkler	Temp rating
1.	Conventional, Pendant, or Upright	68^0 C
2.	Special application side wall type with throw suitable for room size of 8 m length (Extended throw type)	68^0 C
3.	Pendent type (recessed / rosette)	68^0C
4.	High temperature (for kitchen)	72^0C

F2.24.5 Spacing and coverage of sprinkler shall be in accordance with risk classification of area in which they are installed, design density and TAC regulation.

F2.25 Spare Sprinklers

F2.25.1 Provide a lockable enamel painted steel cabinet including following type of spare sprinklers

a)	Conventional/Pendent type	24
b)	Upright	24
c)	Semi concealed.	24
d)	Sidewall	24

e) The cabinet should also contain one pair of wrenches (of each size of the same are different) for the sprinklers.

f) Spare sprinklers shall be of the same specifications as that of the original sprinklers specified.

F2.26 Testing

F2.26.1 All piping in the system shall be tested to a hydrostatic pressure of 1.5 times the working pressure or 14 kg/sq.cm (whichever is more) without drop in pressure for at-least 2 hours.

F2.26.2 Rectify all leakages, make adjustments and retest as required and directed.

F2.27 Cables

F2.27.1 Contractor shall provide control cables from supervisory valves and switches to the annunciation panels.

F2.27.2 All control cables shall be copper conductor pvc insulated armored and PVC sheathed 1100 volt grade.

F2.27.3 All cables shall have stranded conductors. The cables shall be in drums as far as possible and bear manufacturer's name.

F2.27.4 All cable joints shall be made in an approved manner as per standard practice.

F2.28 Cable Trays

F2.28.1 All cables shall be routed in approved locations in coordination with all other services in a proper manner.

F2.28.2 Cable trays shall be of galvanized steel and hung from the ceiling by galvanised rods supported by appropriate size and type of expandable expansion fasteners drilled into the slabs and walls by an electric drill.

F2.29 Annunciation Panel

a) Provide one solid state electronic annunciation panel, fully wired with visual display unit to indicate:

b) Flow condition in any flow indicating valve

c) The panel should give a visual and audible alarm for any of the above conditions.

d) The panel should be standard manufacturer's factory made. All details shall be submitted with the tender.

F2.30 Measurement

F2.30.1 Mild steel pipes shall be measured per linear meter of the finished length and shall include all fittings, flanges, welding, jointing, clamps for fixing to walls or hangers, anchor fasteners, painting and testing complete in all respects.

F2.30.2 Sluice and full way valves, check valves, installation valves, air valves & flow switches shall be measured by numbers and shall include all items necessary and required for fixing and as given in the specifications and bill of quantities.

F2.30.3 Fire hydrants, hose reels, fire brigade connections, orifice flanges shall be measured by number and include all items given in the specifications and bill of quantities.

F2.30.4 Fire hose and boxes specified shall be measured by number and include all items given in specifications and Bill of Quantities.

F2.30.5 Fire extinguishers shall be measured by number and shall include full charge.

F2.30.6 Spare sprinkler cabinets with spare sprinklers specified and spanners shall be measured as per actual item given in the specifications and Bill of Quantities.

F2.30.7 Sprinkler heads shall be measured by numbers.

F2.30.8 Cables and cable trays shall be measured per linear meter shall include clamps, hangers, anchor fasteners complete in all respects.

End of Section F2. Fire Hydrant & Automatic Sprinkler System

Section F3 Fire Pumps & Ancillary Equipment

F3.1 Scope of Work

F3.1.1 Work under this section shall consist of furnishing all labour, materials, equipment and appliances necessary and required to completely install electrically operated and diesel driven pumps as required by the drawings and specified hereinafter or given in the schedule of quantities.

F3.1.2 Without restricting to the generality of the foregoing, the pumps and ancillary equipment shall include the following:-

Electrically operated and diesel driven pumps with motors, base plates and accessories.

Alarm system with all accessories wiring and connections

Pressure gauges with isolation valves & piping, bleed and block valves.

M.S. pipes, valves, suction strainers, delivery headers & accessories.

Foundations, vibration eliminator pads and foundation bolts.

F3.2 General Requirements

F3.2.1 Pumps shall be installed true to level on suitable concrete foundations. Base plate shall be firmly fixed by foundation bolts properly grouted in the concrete foundations.

F3.2.2 Pumps and motors shall be truly aligned by suitable instruments.

F3.2.3 All pump connections shall be standard flanged type with appropriate number of bolts. In case of non standard flanges companion flanges shall be provided with the pumps.

F3.2.4 Manufacturer's instructions regarding installation, connections and commissioning shall be followed with respect to all pumps and accessories.

F3.2.5 Contractor shall provide necessary test certificates and performance charts with NPSH requirement of the pumps from the manufacturer. The Contractor shall provide facilities to the Project Manager or their authorised representative for inspection of equipment during manufacturing and also to witness various tests at the manufacturers works without any cost to the owners.

F3.2.6 Each pump shall be provided with a 150 mm dia pressure gauge, isolation cock and connecting piping, bleed and block valve.

F3.2.7 Provide vibration eliminating pad and connectors for each pump.

F3.2.8 The Contractor shall submit with this tender a list of recommended spare parts for two years of normal operation and quote the prices for the same.

F3.3 Fire, Sprinkler & Jockey Pumps

F3.3.1 Pumping Sets

a) Pumping sets shall be single stage horizontal centrifugal single outlet with cast iron body and bronze dynamically balanced impellers. Connecting shaft shall be stainless steel with bronze sleeve and grease lubricated bearings.

b) Pumps shall be connected to the drive by means of spacer type love joy couplings which shall be individually balanced dynamically and statically.

c) The coupling joining the prime movers with the pump shall be provided with a sheet metal guard.

d) Pumps shall be provided with approved type of mechanical seals.

F3.3.2 Pumps shall be capable of delivering not less than 150% of the rated capacity of water at a head of not less than 65% of the rated head. The shut off head shall not exceed 120% of the rated head.

F3.3.3 The pump shall meet the requirements of the Tariff Advisory Committee and the unit shall be design proven in fire protection services.

F3.4 Electric drive

F3.4.1 Electrically driven pumps shall be provided with totally enclosed fan cooled induction motors. For fire pumps the motors should be rated not to draw starting current more than 3 times normal running current.

F3.4.2 Motors for fire protection pumps shall be at least equivalent to the horse power required to drive the pump at 150% of its rated discharge and shall be designed for continuous full load duty and shall be design proven in similar service.

F3.4.3 Motors shall be wound for class B insulation and winding shall be vacuum impregnated with heat and moisture resistant varnish glass fiber insulated.

F3.4.4 Motors for fire pumps shall meet all requirements and specifications of the Tariff Advisory Committee.

F3.4.5 Motors shall be suitable for 415 ± 10% volts, 3 phase 50 cycles a/c supply and shall be designed for 40 deg C ambient temperature. Motors shall conform to I.S. 325.

F3.4.6 Motors shall be designed for two start system.

F3.4.7 Motors shall be capable of handling the required starting torque of the pumps.

F3.4.8 Contractor shall provide inbuilt heating arrangements for the motors for main pumps to ensure that motor windings shall remain dry.

F3.4.9 Speed of the motor shall be compatible with the speed of the pump.

3.5 Diesel Engine

F3.5.1 Diesel engine shall be of 6 cylinders with individual head assemblies. The engine shall be water cooled and shall include heat exchanger and connecting piping, strainer, isolating & pressure reducing valves, bye-pass line complete in all respects.

F3.5.2 Engine shall be direct injection type with low noise and exhaust emission levels.

F3.5.3 The speed of the engine shall match the pump speed for direct drive.

F3.5.4 The engine shall be capable of being started without the use of wicks, cartridge heater, plugs or either at engine room temperature of 7 deg.C. and shall take full load within 15 seconds from the receipt of the signal to start.

F3.5.5 The engine shall efficiently operate at 38 deg.C ambient temperature at 50 metres above mean sea level.

F3.5.6 Noise level of the engine shall not exceed 105 DBA (free field sound pressure) at 3 meters distance.

F3.5.7 The engine shall be self starting type upto 4 deg C and shall be provided with one 24 volts heavy duty DC battery, starter, cut-out, battery leads complete in all respects. One

additional spare battery shall be provided. The battery shall have a capacity of 180 to 200 ampere hours and 640 amps cold cranking amperage.

F3.5.8 A battery re-charger of 10 to 15 amperes capacity with trickle and booster charging facility and regulator shall be provided.

F3.5.9 The engine shall be provided with an oil bath or dry type air cleaner as per manufacturer's design.

F3.5.10 Engine shall be suitable for running on high speed diesel oil.

F3.5.11 The system shall be provided with a control panel with push button starting arrangement also and wired to the engine on a differential pressure gauge.

F3.5.12 The entire system shall be mounted on a common structural base plate with ant vibration mountings and flexible connections on the suction and delivery piping.

F3.5.13 One self supported one day oil tank fabricated from 5 mm thick MS sheet electrically welded with a capacity of 8 hours working load but not less than 200 lit shall be provided. Level indicating gauge glass on the day oil tank and low fuel level indication on the control panel shall also be provided.

F3.5.14 One exhaust pipe with suitable muffler (residential type) to discharge the engine gases to outside open air as per site conditions shall be provided.

F3.5.15 All other accessories fittings & fixtures necessary and required for a complete operating engine set shall be provided.

F3.5.16 Contractor shall indicate special requirements, if any, for the ventilation of the pump room.

F3.5.17 The materials of construction for the major components are as follows:

Casting : Cast iron

Impeller : Bronze

Shaft : EN-8

Wear Rings : Bronze

Gland Packing : Graphite Asbestos

Type of Bearing : Ball bearing/Roll Bearing

Type of coupling : Flexible couplings

F3.5.18 Instrumentation

The diesel engine shall be provided with the following instrumentation:

a) Temperature indicator in cooling water inlet and outlet

b) Temperature indicator in lubricating oil outlet from the oil cooler
c) Pressure gauge for lubricating oil system
d) Speed indicator
e) Lubricating oil sump level indicator
f) Fuel oil tank level indicator
g) Voltmeter and ammeter in battery charging circuit
h) Cooling water high temperature alarm
i) Oil pressure low alarm

A local instrument panel shall be provided with the engine for mounting all the above instruments and annunciation.

F3.5.19 Pumps and motor engine shall be mounted on a common base frames fabricated from M.S. structural and placed in suitable concrete foundations with the help of approved cushy foot mountings (Anti-vibration pads) to avoid vibrations. The anti vibration pads shall be of heavy duty type.

F3.6 Air Vessel

F3.6.1 Provide one air vessel fabricated from 10 mm M.S. plate with dished ends and suitable supporting legs. Air vessel shall be provided with a 100 mm dia flanged connection from pump, one 25 mm dia drain with valve, one gunmetal water level gauge and 15 mm sockets for pressure switches. The vessel shall be 450 mm dia x 2000 mm high and tested to 20 kg/sq cm pressure.

F3.6.2 The fire pumps shall operate on drop of pressure in the mains as given in para 7 below. The pump operating sequence shall be arranged in a manner to start the pump automatically but should be stopped manually by starter push buttons only.

F3.6.3 Operating conditions for fire & sprinkler pumps.

a)	Operating pressure	6.0 Kg/sq cm	
		Cut in	Cut out
b)	Jockey pump Hydrant and Sprinkler	5.311 kg/sq cm	6.0 kg/sq.cm
c)	Fire Electric Sprinkler Pump	4.961 Kg/sq cm	manual
d)	Fire Electric Hydrant Pump and Sprinkler	4.611 Kg/sq cm	manual
e)	Diesel Engine Driven Stand by	4.261 Kg/sq cm	manual

Notes:

a) Jockey pump shall start and stop through pressure switch automatically.
b) Jockey pump shall stop when main pump starts.
c) Main pump shall start automatically on fall of pressure but stopping shall be manual.

F3.7 Vibration Eliminators

Provide on all suction and delivery lines double flanged reinforced neoprene flexible pipe connectors. Connectors should be suitable for a working pressure of each pump and tested to the test pressure given in the relevant head. Length of the connector shall be as per manufactures details.

F3.8 Measurements:

F3.8.1 Fire, sprinkler pumps shall be measured by numbers and shall include all items as given in the specifications and schedule of quantities.

F3.8.2 Air vessel, fire alarm, installation valve, sluice valves, non return valves, vibration eliminators, flanges and suction strainer shall be measured by numbers and shall include all items as given in the schedule of quantities and specifications.

F3.8.3 Pump headers, shall be measured per linear meter and shall include all items given in the specifications and schedule of quantities.

End of Section F3 Fire Pumps & Ancillary Equipment

Section F4 Commissioning and Guarantees

F4.1 Scope of work

Work under this section shall consist of pre-commissioning, commissioning, testing and providing guarantees for all equipment, appliances and accessories supplied and installed by the contractor under this contract.

F4.2 General Requirements:

F4.2.1 The rates quoted in this tender shall be inclusive of the works given in this section.

F4.2.2 Contractor shall provide al tools equipment, metering and testing devices required for the purpose.

F4.2.3 On award of work, contractor shall submit a detailed proposal giving methods of testing and gauging the performance of the equipment to be supplied and installed under this contract.

F4.3 Precommissioning

F4.3.1 On completion of the installation of all pumps, piping, valves, pipe connections, and water level controlling devices the contractor shall proceed as follows:-

Fire protection system:

i) Check all hydrant valves and close if any valve is open. Also check hat all suction and delivery connections are properly made.

ii) Test run and check rotation of each motor and correct the same if required.

B Pipe work

i) Check all clamps, supports and hangers provided for the pipes.

ii) Fill up pipes with water and apply hydrostatic pressure to the system as given in the relevant section of the specifications. If any leakage is found, rectify the same and retest the pipes.

F4.4 Commissioning & testing

A. Fire hydrant system

i) Pressurise the fire hydrant system by running the main fire pump and after attaining the required pressure shutoff the pump.

ii) Open byepass valve and allow the pressure to drop in the system. Check that the jockey pump cuts-in and cuts out at the pre-set pressures. If necessary adjust the pressure switch for the jockey pump. Close bye-pass valve.

iii) Open hydrant valve and allow the water to flow into the fire water tank in order to avoid wastage of water. The main fire pump should cut-in at the pre-set pressure and should not cutout automatically on reaching the normal line pressure. The main fire pump should stop only by manual push button. However the jockey pump should cut-out as soon as the main pump starts.

iv) Switch off the main fire pump and test check the diesel engine driven pump in the same manner as the electrically driven pump.

v) When the fire pumps have been checked for satisfactory working on automatic controls, open five hydrant valves simultaneously and allow the hose pipes to discharge water into the fire tank to avoid wastage. The electrically driven pump should run continuously for eight hours so that its performance can be checked.

vi) Check each landing valve, male and female couplings and branch pipes for compatibility with each other. Any fitting which is found to be incompatible and does not fit into the other properly shall be replaced by the contractor. Landing valves shall also be checked by opening and closing under pressure.

B. Sprinkler system:

i) Start the pump and develop the required pressure in the sprinkler pipes.

ii) Open the test valve to test the automatic starting of the pump. If necessary, make necessary adjustments in the setting of pressure switch. The sprinkler fire alarm should also operate when the test valve is open.

iii) After satisfactory operation of the pump the contractor shall set up mock fire and test the system.

F4.5 Handing over

F4.5.1 All commissioning and testing shall be done by the contractor to the complete satisfaction of the Project Manager, and the job handed over to the Project Manager, or his authorised representative.

F4.5.2 Contractor shall also hand over, to the Project Manager, all maintenance & operation manuals and all other items as per the terms of the contract.

F4.6 Guarantees

F4.6.1 The contractor shall submit a warranty for all equipment, materials and accessories supplied by him against manufacturing defects, malfunctioning or under capacity functioning.

F4.6.2 The form of warranty shall be as approved by the Project Manager.

F4.6.3 The warranty shall be valid for a period of one year from the date of commissioning and handing over.

F4.6.4 The warranty shall expressly include replacement of all defective or under capacity equipment. Project Manager may allow repair of certain equipment if the same is found to meet the requirement for efficient functioning of the system.

F4.6.5 The warranty shall include replacement of any equipment found to have capacity lesser that the rated capacity as accepted in the contract. The replacement equipment shall be approved by the Project Manager.

End of Division F4 Commissioning and Guarantees

Section F5 Electrical Installations

F5.1 Scope

The scope of this section comprises of fabrication, supply, erection, testing and commissioning of electric control panels, wiring and earthing of all air conditioning equipment, components and accessories, including supply, installation and wiring of remote control-cum-indicating light panel.

F5.2 General

Work shall be carried out in accordance with the Specifications, Local Rules, Indian Electricity Act 1910 as amended upto date, and rules issued thereunder, Regulations of the Fire Insurance Company and relevant BIS Code of Practice.

F5.3 Wiring System

All power wiring shall be carried out with 1100 volts grade PVC insulated, armoured, overall PVC sheathed aluminium conductor cables for sizes above 6 sq mm. Sizes 6 sqmm and below the power wiring shall be of copper conductor only. Cables shall be sized by applying proper derating factor. All control wiring shall be carried out by using 650 volts PVC insulated copper conductor wires in race ways or in conduit. Minimum size of control wiring shall be 1.5 sq.mm PVC insulated copper conductor wires. Minimum size of conductor for power wiring shall be 4 sq.mm 1100 volts grade PVC insulated copper conductor wires in conduit.

F5.4 Construction Features

F5.4.1 The control panel shall be metal enclosed sheet steel cubicle, indoor type, dead front, floor mounting / wall mounting type. The control panel shall be totally enclosed, and vermin proof. Gaskets between all adjacent units and beneath all covers shall be provided to render the joints dust proof. Control panels shall be arranged in multi-tier formation. All doors and covers shall be suitable for double padlocking .All mild steel sheets used in the construction of control panels shall be 14 SWG thick for floor mounted and 16 SWG for wall mounting and shall be folded and braced as necessary to provide a rigid support for all components. Joints of any kind in sheet metal shall be seam welded, all welding slag grounded off and welding pits wiped smooth with Plumber metal.

F5.4.2 All panels and covers shall be properly fitted and square with the frame and holes in the panel correctly positioned. Fixing screws shall enter into holes tapped into an adequate thickness of metal or provided with hank nuts. Self threading screws shall not be used in the construction of control panels. Base channel of 75 mm x 75 mm x 5 mm thick shall be provided at the bottom. Minimum clear space of 200 mm between the floor of control panel and bottom most unit (MCB or Bus Bar) shall be provided.

F5.4.3 The control panels shall be of adequate size with a provision of 25% spare space to accommodate possible future additional switch gear. Knockout holes of appropriate

size and number shall be provided in the control panels in conformity with the location of incoming and outgoing conduits / cables. All equipment such as meters and indicating lamps etc. shall be located adjacent to the unit with which it is associated and care shall be taken to achieve a neat and symmetrical arrangement. Facility shall be provided for termination of cables from top of the control panel. Clamps shall be provided to support the weight of the cables. All power wiring inside the control panel shall be colour coded and control wiring ferruled for easy identification. Circuit diagram showing the arrangement of circuits shall be pasted on the inside of panel door and covered with transparent plastic sheet and all labeling shall be provided in engraved anodized aluminium / bakelite strips on the front face of the panel board.

F5.5 Circuit Compartment

Each circuit breaker, contactor and relay shall be housed in a separate compartment and shall have steel sheets on top and bottom of compartment. Sheet steel hinged lockable door shall be duly interlocked with the breaker in the `ON' position. Safety interlocks shall be provided to prevent the breaker or contactor from being drawn out when the breaker is in `ON' position. The door shall not form an integral part of the draw out portion of the panel. Sheet steel barriers shall be provided between the tiers in a vertical section.

F5.6 Instrument Accommodation

Adequate space shall be provided for accommodating instruments, indicating lamps, control contactors and control fuses etc. These shall be accessible for testing and maintenance without any danger of accidental contact with live parts of the circuit breaker and bus bar.

F5.7 Bus Bars and Bus Bar Connections

The bus bar and interconnections shall be of aluminium and of rectangular cross sections suitable for full load current for phase bus bars, and half rated current for neutral bus bar and shall be extensible on either side. The bus bars and interconnections shall be insulated with PVC sleeve / tapes and shall be color coded. Alternatively special insulating paints / materials may be used for the purpose.

All bus bars shall be supported on unbreakable, non hygroscopic insulated supports at regular intervals, to withstand the forces arising in case of short circuit in the system. All bus bars shall be provided in separate chamber and properly ventilated. All bus bars connections, in main control panels shall be done by drilling holes with cadmium plated / hot dipped galvanized bolts, nuts and washers.

All bus bars connections in smaller control panels shall be done by drilling hole and connecting by brass bolts and nuts.

All connections between the bus bar and breaker, and between breaker and contactor shall be through copper strips of proper size to carry rated current and shall be insulated with PVC sleeves.

F5.8 Raceways

A horizontal race way with screwed covers shall be provided at the top to take interconnecting control wiring between different vertical sections.

F5.9 Cable compartments

Cable compartment of adequate size shall be provided in the control panels for easy termination of all incoming and outgoing cables entering from bottom or top. Adequate and proper supports shall be provided in cable compartments to support cables.

F5.10 Indications

1. `ON' lamps shall be provided on all outgoing feeders.
2. Cable alley and bus chamber shall be identified on all panels.

F5.11 Rubber Mat

Rubber mat shall be provided to cover the full length of front of all panels and rear of panels where back space shall be available for working from the rear.

F5.12 Materials

All materials shall be of the best quality complying with the BIS (Bureau of Indian Standards) specifications. Materials used shall be subject to the approval of the Owner's site representative and samples of the same shall be furnished where required.

F5.12.1 Moulded Case Circuit Breaker

MCCB shall comprise of switching mechanism, contact system, are extinguishing device and the tripping unit, Contained in a Compact, high strength, heat resistant, flame retardant, insulating moulded case with high withstand capability against thermal and mechanical stress.

Switching mechanism shall be of Quick Make- Quick Break type and the trip command shall override all other commands. MCCB shall employ maintenance free contact system to minimise the let thru `energies while handling abnormal currents.

The handle position shall give positive indication of `ON' `OFF' or tripped.

MCCB shall conform to IS- 2516 (Part I & II/Sec.1) 1985.

F5.12.2 Miniature Circuit Breaker

Miniature circuit breakers shall be quick make and break type, and shall conform to Relevant Indian Standards. The housing shall be heat resistant and having a high impact strength. The fault current shall not be less than 9 KA at 230 V and shall be BIS approved. MCBs shall be flush mounted and shall be provided with trip free manual operating liver and `ON" and `OFF" indications. The contacts shall be provided to quench the arc immediately. MCB shall be provided with magnetic thermal releases for over current and short circuit protection. The over load or short circuit device shall have a common trip bar in the case of D P, TP and TPN miniature circuit breakers.

F5.12.3 Rotary Switches

Switches upto 60 amps shall be rotary type with compact and robust construction, built up from one or more stacks with contacts and a positioning mechanism with stop as required. Rotary switches shall have HRC fuse fittings of appropriate rating.

F5.12.4 Selector Switch

Where called for, selector switches of rated capacity shall be provided in control panels, to give the choice of operating equipment in selective mode.

F5.12.5 Starters

Each motors shall be provided with a starter of suitable rating. Starters shall be in accordance with relevant BIS Codes. All Star Delta and ATS Starters shall be fully automatic.

Starters contactors shall have 3 main and 2 Nos. NO / NC auxiliary contacts and shall be air break type suitable for making and breaking contact at minimum power factor of 0.35. For design consideration of contactors the starting current of connected motor shall be assumed to be 6 times the full load current of the motor in case of direct-on-line starters and 3 times the full load current of the motor in case of Star Delta / Reduced Voltage Starters. The insulation for contactor coils shall be of class "B".

Operating coils of contactors shall be suitable for 230 / 415 $\pm$ 10% volts AC, 50 cycles supply system. The contactors shall drop out when voltage drops to 90% of the rated voltage.

The housing of the contactors shall be heat resistant and having high impact strength. Each starter shall have thermal overload protection on all three phases.

F5.12.6 Over Load Relays

Contactors shall be provided with a three element, positive acting ambient temperature compensated time lagged hand-reset type thermal over load relays with adjustable setting. Hand-reset button shall be flush with the front door for resetting with starter compartment door closed. Relays shall be directly connected for motors upto 35 HP capacity. C.T operated relays shall be provided for motors above 35 HP capacity. Heater circuit contactors may not be provided with overload relays.

F5.12.6 Current Transformers

Current transformers shall be of accuracy class I and suitable VA burden for operation of the connected meters and relays. These shall be resin bonded and epoxy coated.

F5.12.7 Single Phase Preventers

Single phase preventers shall be provided as per Bill of Quantities and shall be in conformity with relevant BIS Standards. Single phase preventers shall act when the supply voltage drops down to 90% of the rated voltage or on failure of one or more phases.

F5.12.8 Time Delay Relays

Time delay relays shall be adjustable type with time delay adjustment from 0-180 seconds and shall have one set of auxiliary contacts for indicating lamp connections.

F5.12.9 Indicating Led (22 mm dia) and Metering

All meters and indicating lamps shall be in accordance with BS 37 and BS 39. The meters shall be flush mounted and draw out type. The indicating lamp shall be of LED type. Each main panel shall be provided with voltmeter 0-500 volts with three way and off selector switch, CT operated ammeter of suitable range with three Nos. CTs of suitable ratio with three way and off selector switch, phase indicating lamps, and other indicating lamps as called for. Each phase indicating lamp shall be backed up with 5 amps fuse. Other indicating lamps shall be backed up with fuses as called for.

F5.12.10Toggle Switch

Toggle switches, where called for, shall be in conformity with relevant BIS Codes and shall be of 5 amps rating.

F5.12.11Push Button Stations

Push button stations shall be provided for manual starting and stopping of motors / equipment as called for. Green and Red colour push buttons shall be provided for `Starting' and `Stopping' operations. `Start' or `Stop' indicating flaps shall be provided for push buttons. Push buttons shall be suitable for panel mounting and accessible from front without opening door, Lock lever shall be provided for `Stop' push buttons. The push button contacts shall be suitable for 6 amps current capacity.

F5.12.12Conduits

Conduits shall be of mild steel and shall be Hard drawn, stove enameled inside and outside with minimum wall thickness of 1.6 mm for conduits upto 32mm diameter and 2 mm wall thickness for conduits above 32 mm diameter. GI pull wires shall be installed in the conduit while laying the conduit.

F5.12.12Cables

M.V.cables shall be PVC insulated aluminium conductor and armoured cables conforming to BIS Codes. Cables shall be armoured and suitable for laying in trenches, duct, and on cable trays as required. M.V Cables shall be termite resistant. Control cables and indicating panel cables shall be multi core PVC insulated copper conductor and armoured cables.

F5.12.13Wires

1100 volts grade PVC insulated copper conductor wires in conduit shall be used.

F5.13 **Cable Laying** Cable shall be laid generally in accordance with BIS Code of Practice. Cables shall be laid on 14 gage perforated MS sheet cable trays, and cable drops / risers shall be fixed to ladder type cable trays fabricated out of steel angle. Access to all cables shall be provided to allow cable withdrawal / replacement in the future. Where more than one cable is running, proper spacing shall be provided to minimise the loss in current carrying capacity. Cables shall be suitably supported with Galvanized saddles when run on walls / trays. When buried, they shall be laid in 350 mm wide and 750 mm deep trench and shall be covered with 250 mm thick layer of soft sifted sand & protected with bricks, tiles. Special care shall be taken to ensure that the cables are not damaged at bends. The radius of bend of the cables when installed shall not be less than 12 times the diameter of cable. 1.1 KV cable shall be buried 600 mm below ground level.

F5.14 **Wire Sizes**

For all single phase / 3 phase wiring, 1100 volts grade PVC insulated copper conductor wires shall be used. The equipment inside plant room and AHU room shall be connected to the control panel by means of insulated aluminium conductor wires of adequate size. An isolator shall be provided near each motor / equipment wherever the motor / equipment is separated from the supply panel through a partition barrier or through ceiling construction. PVC insulated single strand aluminium conductor wires shall be used inside the control panel for connecting different components and all the wires inside the control panel shall be neatly dressed and plastic beads shall be provided at both the ends for easy identification in control wiring.

. The minimum size of control wiring shall be 1.5 sq.mm PVC insulated stranded soft drawn copper conductor wires drawn through conduit to be provided for connecting equipment and control panels.

Power wiring cabling shall be of the following sizes :

i. Upto 5 HP motors/5 KW heaters.	3 x 4 sq.mm copper conductor wires.
ii From 6 HP to 10 HP motors 6 KW to 7.5 KW heaters.	3 x 6 sq.mm copper conductor wires.
iii. From 12.5 HP to 15 HP motors.	2 Nos. 3 x 6 sq.mm copper conductor wires.
iv. From 20 HP to 25 HP motors.	2 Nos. 3 x 10 sq.mm aluminium conductor armoured cables.
v. From 30 HP to 35 HP motors.	2 Nos. 3 x 16 sq.mm aluminium conductor armoured cables.
vi. From 40 HP to 50 HP motors.	2 Nos. 3 x 25 sq.mm aluminium conductor armoured cables.
vii. From 60 HP to 75 HP motors.	2 Nos. 3 x 50 sq.mm aluminium conductor armoured cables.
viii. 100 HP motors.	1 No. 3 x 150 sq.mm aluminium conductor armoured cables.
ix. 150 HP motor.	1 No.3 x 240 sq.mm aluminium conductor armoured cables

x.	250 HP motor.	2 Nos. 3 x 240 sq.mm aluminium conductor armoured cables.
xi.	400 HP motor.	3 Nos. 3 x 240 sq.mm aluminium conductor armoured cables.
xii.	600 HP motor.	3Nos. 3 x 400 sq.mm aluminium conductor armoured cables.

All the switches, contactors, push button stations, indicating lamps shall be distinctly marked with a small description of the service installed. The following capacity contactors and overload relays shall be provided for different capacity motors.

TYPE OF STARTER	CONTACTOR CURRENT CAPACITY	OVERLOAD RELAY RANGE
5 HP Motors	D O L 16 amps	6-10 amps
7.5HP Motors	D O L 16 amps	10-16 amps
10 HP Motors	D O L 32 amps	13-21 amps
12.5HP Motors	Star Delta 16 amps	10-16 amps
15 HP Motors	Star Delta 25 amps	10-16 amps
20 HP Motors	Star Delta 32 amps	13-21 amps
25 HP Motors	Star Delta 32 amps	13-21 amps
30 HP Motors	Star Delta 40 amps	20-32 amps
35 HP Motors	Star Delta 40 amps	20-32 amps
40 HP Motors	Star Delta 40 amps	28-42 amps
45 HP Motors	Star Delta 63 amps	28-42 amps
50 HP Motors	Star Delta 63 amps	28-42 amps
60 HP Motors	Auto Transformers/ Reduced Voltage. 125 amps	45-70 amps
75 HP Motors	-do- 125 amps	90-150 amps

100 HP Motors	-do-	200 amps	operated Relay
135 HP Motors	-do-	300 amps	-do-
150 HP Motors	-do-	300 amps	-do-
200 HP Motors	-do-	300 amps	-do-
250 HP Motors	-do-	400 amps	-do-
300 HP Motors	-do-	400 amps	do-
400 HP Motors	-do-	600 amps	-do-
600 HP Motors.	-do-	900 amps	-do-

F5.15 Earthing

Earthing shall be copper strips / wires the main panel shall be connected to the main earthing system of the building by means of 2 Nos. 25 mm x 3 mm copper tapes. All single phase metal clad switches and control panels be earthed with minimum 2 mm diameter copper conductor wire. All 3 phase motors and equipment shall be earthed with two numbers distinct and independent copper wires / tapes as follows :

i. Motors upto and including 10 HP rating.	2 Nos 3 mm dia copper wires.
ii. Motors 12.5 HP to 40 HP capacity.	2 Nos.4 mm dia copper wires.
iii. Motors 50 to 75 HP capacity.	2 Nos 6 mm dia copper wires.
iv. Motors above 75 HP.	2 Nos 25 mm x 3 mm copper tapes.

All switches shall be earthed with two numbers distinct and independent copper wires/tapes as follows :

i. 3 phase switches and	2 Nos 3 mm dia copper

control panels upto 60	wires. amps rating.
ii. 3 phase switches and control panels 63 amps to 100 amps rating.	2 Nos 4 mm dia copper wires.
iii. 3 phase switches and control panels 125 amps to 200 amps rating.	2 Nos 6 mm dia copper wires.
iv. 3 phase switches, control panels, bus ducts, above 200 Amps rating	2 Nos 3 mm x 25 mm copper tapes.

The earthing connections shall be tapped off from the main earthing of electrical installation. The over-lapping in earthing strips at joints where required shall be minimum 75 mm. These straight joints shall be riveted with brass rivets & brazed in approved manner. Sweated lugs of adequate capacity and size shall be used for all termination of wires. Lugs shall be bolted to the equipment body to be earthed after the metal body is cleaned of paint and other oily substance and properly tinned.

F5.16 Drawings

Shop drawings for control panels and wiring of equipment showing the route of conduit/cable shall be submitted by the contractor for approval of Project Managers/ Consultant before starting the fabrication of panel and starting the work. On completion, four sets of complete "As-installed" drawings incorporating all details like, conduits routes, number of wires in conduit, location of panels, switches, junction/pull boxes and cables route etc. shall be furnished by the Contractor.

F5.17 Testing

Before commissioning of the equipment, the entire electrical installation shall be tested in accordance with relevant BIS Codes and test report furnished by a qualified and authorised person. The entire electrical installation shall be got approved by Electrical Inspector and a certificate from Electrical Inspector shall be submitted. All tests shall be carried out in the presence of Supervisor.

F5.18 Painting

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

F5.19 Labels and Tags

Engraved PVC labels shall be provided on all incoming and outgoing feeders switches. Circuit diagram showing the arrangements of the circuit inside the control panel shall be pasted on inside of the panel and covered with transparent plastic sheet. All cables terminations at panels and at equipments shall be provided with tags as approved by Project Managers.

F5.20 All panels to have provision for padlocking and all MCCB's / MCB's to have provision for locking in off position.

F5.21 Measurement of Electrical Control Panels

Panels shall be counted as number of units. Quoted rates shall include as lump sum (NOT measurable lengths) for all internal wiring, power wiring and earthing connections from the control panel to the starter and to the motor, control wiring for inter-locking, power and control wiring for automatic and safety controls, and control wiring for remote start/stop as well as indication as per the specifications. The quoted rate for panel shall also include all accessories, switchgear, fuses, contactors, indicating meters and lights as per the specifications.

End of Section F5 Electrical Installations

Section F6 : List of Approved Makes of Materials

S.No.	Materials	I.S. no	Brand	Manufacturer Name
1	M. S. Pipes	1239	TATA	TISCO Tubes Divn.
		3589		Jamshedpur.
			Jindal	Jindal Tube Co. Hissar.
2	Forged Steel Fittings	1879		TRUE FORGE/ SIMLESS/V.S.FORGE
		(Part I to X)		
3	Gunmetal Valves (fullway Check and Globe Valves)	778	Leader	Leader Engg. Works, Jalandhar.
			SANT	Sant Metal Works, Jalandhar
			Zoloto	Zoloto Marketting Co
4	C.I.Double flanged sluice Valves	780	Kirloskar	Kirloskar Bros.Ltd, pune .

			Kartar	
			Leader	Leader Engg. Works, Jalandhar.
5	Butterfly valves/ Wafer type Check Valve			Audco /Advance / SKF/ Veesons / Sant / Zoloto
6	C.I.Double Flanged Non Return Valve	5312	Kirloskar IVC Leader	Kirloskar Bros. Ltd. Pune Indian Valve Co. LTD. Calcutta Leader Engg. Works.
7	Fire Hydrant Valves.	5290	Minimax Newage Superex	Steelage Industries Ltd., Bombay. Newage, Gujrat Superex Fire Engineers. Wazirpur
7.1	Fire Extinguishers.		Minimax Cease Fire Kidde	Steelage Industries Ltd., Bombay. Cease Fire Ind. Noida
8	Fire Hose Pipes	8423 636	PADMINI JYOTI R R.L. Hose	Padmini Ind.Ltd C.P. Hose Newage Ind. Rajendra Place
9	Fire Aid Fire Hose Reels	884	(Drum & Bracket).	MINIMAX/NEWAGE /SUPEREX

10	Sprinkler Heads		SPRAYSAFE H.D. TYCO Newage Omax	Spraysafe Co, U.K. H.D.fire Newage Grinnel, Central,
11	Horizontal Centrifugal Pumps			Kirloskar, Mather & Platt/ KSB
12	Electric Motors			Kirloskar, Crompton Siemens,
13	Electrical Switch Gear & Starters.			Siemens, L & T
14	Cables			Skytone/GLOSTER/HAVELS /POLYCAB
15	Flow meter			Scientific Equpmt.(P) Ltd., Shali Banda Hyderabad-500263
16	Suction Strainer		Leader Sant Zoloto	LeaderEngg.Works Jalandhar
17	Vibration Eliminator Connectors		Resistoflex	Relay Corp. NOIDA
18	Single Phasing Preventor (Current operated)			L & T, Siemems, Minilec
19	Pipe coat material (pipe protection)		PYPKOTE	Integrated Water-Proofing Co Madras
20	Flow Switches		Potter	System Sensor
21	Diesel Engine	10000	TAC Approved	ASHOKLEYLAND/KIRLOSKAR/ CUMMINS
22	Main control panel(Powder coated)			AdvanceElect.Control /Tricolite/Vidut Control/Rajeev Associates
23	Fire Brigade Inlet	903		MINIMAX/NEWAGE/SUPEERE X
24	Rubber Hose Pipe	5132		PADMINI / JYOTI/TIGER

25	Hose Couplings branch	903	Pipe & Nozzle	MINIMAX/NEWAGE/SUPEREX INDIAN RAYON/SUKAN/SBJ
26	Pressure Switches		TAC	DANFOSS/SWITZER
27	Pressure Gauge	3624(CL-I)		H.GURU/FIEBIG
28	Battery			EXIDE/PRESTOLITE
29	Welding Rods			Advani
30	Paint			J&N/ASIAN/NEROLAC/BERGER
31	Annunciater Panel For Sprinkler System	2189		PCD/SAFEWAY/AGNI(INDIA)
32	Fire Alarm, Fire Fighting and Plumbing work-Agency/vender--			MEP Contractor and Engineers. Hytechengineers Seam Risk solutions. Smart fire and life safety solution .
33	Contactor			L&T/SIEMENS/GE
34	Thimbles/Ferrules			DOWEL
35	Cable Glands			Commex/Power/Gripwell
36	Power Capacitor			L&T/Crompton/Asian
37	Measuring Meter			L&T/Siemens/Rishab
38	M.S.Conduit			Steel Craft/BEC

Table 7 — *(Continued)*

Sl No.	Type of Building Occupancy	Type of Installation								Water Supply (litre)		Pump Capacity (litre/min)	
		Fire Extinguisher	First Aid Hose Reel	Wet Riser	Down Comer	Yard Hydrant	Automatic Sprinkler System	Manually Operated Electronic Fire Alarm Systems (*see* Note 1)	Automatic Detection and Alarm System (*see* Note 2)	Under-ground Static Water Storage Tank Combined Capacity for Wet Riser, Yard Hydrant and Sprinklers per Set of Pumps	Terrace Tank over Respective Tower Terrace	Pump Near Underground Static Water Storage Tank (Fire Pump) with Minimum Pressure of 3.5 kg/cm^2 at Remotest Location	At the Terrace Tan Level with Minimum Pressure of 3.5 kg/cm^2
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)
	iii) More than ground plus one floor	R	R	R	NR	R	R	R	R	100 000	10 000	(*see* Note 10)	450
3)	Multi-Level Car Parking (MLCP)s	R	R	R	NR	R	R	R	NR	[illegible]	[illegible]	(*see* Note 11)	900
	HAZARDOUS BUILDINGS (J) (*see* Note 20)												
1)	Up to 15 m in height												
	i) Single Storey Building	R	R	R	NR	R	R	R	R	Minimum 240 min firefighting requirements	NR	(*see* Note 21)	NR
	ii) More than one floor building but not exceeding 15 m	R	R	R	R	R	R	R	R	Minimum 240 min firefighting requirements	50 000	(*see* Note 21)	900

R – Required
NR – Not Required

NOTES

1 MOEFA System shall also include talk-back system and public address system for the occupancies given in the table for (d) (1) (iii) under A-5, (a) (1) (iv) and (a) (2) under D-1 to D-5, in all buildings 15 m and above in height, except for A-3 and A-4 occupancies where these shall be provided for buildings of height 24 m and above. These shall also be provided in car parking areas more than 300 m^2 and in multi-level car parking irrespective of their areas.

2 Automatic detection and alarm system is not required to be provided in car parking area. Such detection system shall however be required in other areas of car parking such as electrical rooms, cabins and other areas.

3 Buildings above 15 m in height are not to be permitted for occupancies A-1 and A-2.

4 Required to be installed in basement, if area of basement exceeds 200 m^2.

5 Required to be provided if basement area exceeds 200 m^2.

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Table 7 — (*Concluded*)

6 Additional value given in parenthesis shall be added if basement area exceeds 200 m².

7 Required to be provided for buildings with more than two storeys (Ground + One).

8 Required to be provided for buildings with height above 15 m and above.

9 Sprinklers shall be fed water from both underground static water storage tank and terrace tank.

10 Provide required number of sets of pumps each consisting of one electric and one diesel pump (stand by) of capacity 2 280 litre/min and one electric pump of capacity 180 litre/min (*see* Fig. 11) (*see also* notes 22 and 23).

11 Provide required number of sets of pumps each consisting of two electric and one diesel pump (stand by) of capacity 2 280 litre/min and two electric pump of capacity 180 litre/min (*see* Fig. 12) (*see also* Notes 22 and 23).

12 Provide required number of sets of pumps each consisting of two electric and one diesel pump (stand by) of capacity 2 850 litre/min and two electric pump of capacity 180 litre/min (*see* Fig. 12) (*see also* Notes 22 and 23).

13 Lower levels in high rise buildings 60 m or above in height are likely to experience high pressure and therefore, it is recommended to consider multi-stage, multi-outlet pumps (creating pressure zones) or variable frequency drive pumps or any other equivalent arrangement.

14 Provide required number of sets of pumps each consisting of one electric and one diesel pump (stand by) of capacity 1 620 litre/min and one electric pump of capacity 180 litre/min (*see* Fig. 11) (*see also* Notes 22 and 23).

15 Required to be provided for buildings with more than one storey.

16 Buildings above 30 m in height not to be permitted for Group B, Group C, Group D and Group F occupancies.

17 The requirements given in this table for Group G Industrial Buildings are for small scale industry units. For other industries the requirements will have to be worked out on the basis of relevant Indian Standards and also in consultation with the local fire authorities.

18 Buildings above 18 m in height not to be permitted for G-1 and G-2 occupancies.

19 Buildings above 15 m in height not to be permitted for G-3 occupancies.

20 Buildings above 15 m in height not to be permitted for Group H and Group J occupancies. However, buildings above 45 m in height shall not be permitted for multi-level car parking (MLCP) occupancy.

21 Pump capacity shall be based on the covered area of the building.

22 One set of pumps shall be provided for each 100 hydrants or part thereof, with a maximum of two sets. In case of more than one pump set installation, both pump sets shall be interconnected at their delivery headers.

23 Alternative to provisions of additional set of pumps, the objective can be met by providing additional diesel pump of the same capacity and doubling the water tank capacity as required for one set of pumps.

24 As per the requirement of local authority dry riser may be used in hilly areas, industrial areas or as required.

PART 4 FIRE AND LIFE SAFETY

PUMP CALCULATION SHEET AS PER NBC 2016 PART-4

TECHNICAL SPECIFICATION FOR PLUMBING SYSTEMS

PART 1 – General provisions

1.01 DESCRIPTION

The specifications and mode of measurements for Plumbing works shall be in accordance with C.P.W.D. specifications 1996 Volumes I to VI.

Unless otherwise specified in the nomenclature of individual item or in the specifications, the entire work shall be carried out as per the C.P.W.D. specifications with upto date correction slips up to the date of opening of tender.

For the item not covered under CPWD Specifications mentioned above, the work shall be executed as per latest relevant standards/codes published by B.I.S. inclusive of all amendments issued thereto or revision thereof, if any, up to the date of opening of tenders.

In case of B.I.S. codes/specifications are not available, the decision of the Engineer based on acceptable sound engineering practice and local usage shall be final and binding on the contractor.

However, in the event of any discrepancy in the description of any item as given in the schedule of quantities or specifications appended with the tender and the specifications relating to the relevant item as per CPWD specifications mentioned above, or in drawings the former shall prevail.

The scope of works for all plumbing works and systems comprise supply, delivery, installation, testing and commissioning, handover and warranty all as described or reasonably implied in the Contract. The Contractor is obliged to provide fully functioning works and systems in conformance with the requirements of the Contract. In the event certain items are not fully described or indicated in the Contract, but deemed essential by the Engineer (in all reasonableness) for the performance of the works and systems then the provision of such items shall form part of the Contractors scope of works at no additional cost to the Employer.

The Contractor shall be responsible to co-ordinate the equipment and services and shall produce properly co-ordinated shop drawings to demonstrate the installation comply with the performance requirement with shop drawing, calculations and details.

The drawings shall have to be properly correlated before executing the work. In case of any difference noticed between the drawings, final decision, in writing of the Engineer shall be obtained by the Contractor.

Shop drawings shall take into account actual measurement and setting out dimensions/levels obtained and determined by the Contractor on site, actual equipment/material used, actual routing of services, co-ordination with all installation, and site conditions/constraints.

All materials to be used on works shall bear I.S. certification mark unless specifically permitted otherwise in writing. In case I.S. marked materials are not available (not produced) , the materials used shall conform to I.S. code or CPWD specifications as applicable in this contract.

1.02 SCOPE OF WORKS for PLUMBING AND SANITARY INSTALLATION

A .Down feed water supply distribution system to all sanitary fixtures and wet areas as required. Making tapping from the municipal main for receiving water supply to drinking water storage tank. Domestic pumps and pumping line from pump room to storage tank and installation of irrigation, washing lines and domestic lines as indicated in the drawings. Development of Tubewell as per site requirements.

B. Soil, Waste, Vent and Rain water down takes and their connection to external sewerage and drainage system, sewage and drainage sump pumps.

C Internal Sewerage and Drainage system.

D. Liaison with the local supply Authority to obtain and coordinate provision of incoming city water supply, discharge points to city sewer and storm water drainage disposal point as required.

E. Complete internal storm water drainage collection and conveyance system and associated accessories.

F. Complete internal sewer and floor wash wastewater drainage collection and conveyance system and associated accessories.

All associated electrical works.

All associated automatic control works.

All interfacing works with the civil structures.

All associated interfacing works with other trades including electrical, fire alarm and protection, ventilation, etc.

Other works as shown on the drawings and described elsewhere in the Contract documents.

1.03 QUALITY ASSURANCE

A. Comply with the current applicable codes, ordinances, and regulations of the authority or authorities having jurisdiction, the rules, regulations and requirements of the utility companies/authorities serving the project and the Owner's insurance underwriter.

B. Drawings, specifications, codes and standards are minimum requirements. Where requirements differ, the more stringent codes shall apply.

C. The Engineer reserves the right to inspect and reject any part of the Works not complying. The Contractor shall replace such rejected works without cost variation and delay to the Contract.

D. Approval or acceptance by the Engineer shall not relieve the Contractor of his responsibilities under the Contract for the quality of materials and the standard of workmanship in the Works.

E. No work shall be covered up or put out of view without the agreement of the Engineer. The Contractor shall provide/allow the Engineer full opportunity for the examination and measurement of any work which is about to be covered or put out of view. Upon request by the Engineer, the Contractor shall expose their Works and allow/provide access to the Engineer to inspect any part of the Works during the course of the manufacturing or site installation/erection.

F. When requested by the Engineer, the Contractor shall submit evidence including written certificates and full testing reports from approved/recognised testing organisation certifying that his proposed equipment or material has been tested and conform with the specified standard.

1.04 CLIMATE CONDITIONS

A. The Contractor shall warrant that all materials and equipment are suitable for continuous use and operation in the climatic conditions encountered on site and at basement levels.

B. All equipment and materials shall be fully tropicalised and suitable for use in the peculiar local climate and operating conditions. All equipment/system shall be suitable for operation with outdoor dry bulb temperature of at least up to 46°C and relative humidity of up to 100%.

PART 2 – PRODUCTS

2.01 MATERIALS AND EQUIPMENTS

A. Provide products and materials that are new, clean, free of defects, and free of damage and corrosion.

B. Products and materials shall not contain asbestos or any other material which is considered hazardous by the authority having jurisdiction.

C. Replace materials of less than specified quality and relocate work incorrectly installed as directed by the Engineer. Install materials and equipment with qualified trade people.

D. Maintain uniformity of manufacturer for equipment used in similar application and sizes.

E. Fully lubricate equipment where required.

F. Follow manufacturer's instructions for installing, connecting, and adjusting equipment. Provide a copy of such instructions at the equipment during installation.

G. Equipment capacities, ratings, etc, are scheduled or specified for job site operating conditions.

H. Energy consuming equipment shall meet local energy ordinances and by-laws.

PART 3 – EXECUTION

3.01 COORDINATION OF WORK

A. The drawings show the general arrangement of equipment and appurtenances. Follow these drawings as closely as the actual construction permits. Provide off-sets, fittings, and accessories which may be required but not shown on the drawings. Investigate the site, and review drawings to determine conditions affecting the work, and provide such work and accessories as may be required to accommodate such conditions.

B. The drawings show only the general run of services and approximate location of equipment, outlets, panels, etc. Any significant changes in location of equipment, outlets, panels, etc., necessary in order to meet field conditions shall be brought to the determine attention of the Engineer for review before such alterations are made. Modifications shall be made at no additional cost to the Contract.

C. Carefully check space requirements to ensure that equipment can be installed in the space allotted.

D. Furnish and set sleeves for passage of pipes through structural masonry and concrete walls and floors and elsewhere as required for the proper protection of pipes passing through building surfaces.

E. Coordinate with the local utility companies/authorities for their requirements for service connections and provide all necessary provisions, grounding, materials, equipment, labor, testing, and appurtenances.

F. Before commencing works, examine adjoining works on which this work is in any way affected and report conditions which prevent performance of the works. Become thoroughly familiar with actual existing conditions to which connections must be made or which must be changed or altered. The Contractor is responsible to any modifications required due to service not properly coordinated.

3.02 EXAMINATION OF SITE

A. Prior to the submitting of bids, visit the project site and become familiar with all conditions affecting the proposed installation and make provisions as to the cost thereof.

B. The Contract Documents do not make representations regarding the character or extent of the sub-soils, water levels, existing structural, Plumbing & Sanitary and electrical installations, above or below ground, or other sub-surface conditions which may be encountered during the work, based on examination of the site or other information. Failure to examine the drawings or other information does not relieve the Contractor of responsibility for satisfactorily completion of the work.

3.03 AS-NEW CONDITIONS

A. At the time of handover of the Works after the Taking Over Certificate, the whole installation shall be in 'as-new' conditions. The Contractor shall, during the course of the Contract, protect all fixtures, pipes, pumps and equipment and shall restore/repaint as necessary before handover of the installation.

3.04 DEFECT NOTIFICATION PERIOD

A. Defects Notification Period for Plumbing & Sanitary systems shall be 12 months. The period commencing on the date of issue of the Taking Over Certificate. During the Defect Notification Period, the Contractor shall provide a 24-hour 'call-out' service to repair any equipment that has broken down.

B. Immediately answering the breakdown calls, the Contractor shall attend to such calls within a maximum time limit of 2 hours during night and 1 hour during daytime of receiving such calls.

C. During the Defect Notification Period, the Contractor shall at his own cost remedy and make good with all faults

or defects in the Works, which in the opinion of Engineer, is due to faulty materials, workmanship. The

Contractor shall indemnify the employer and/or the General Contractor against any damage or injury to the

Building contents and/or occupants arising from such faults or defects.

D. If the Contractor fails to remedy such faults or defects within a reasonable time, the Employer may proceed to do so at the expense of the Contractor and without prejudice to such other rights as the Employer may have under the Contract.

E. The Contractor shall also refer to other requirements in the relevant clauses of the contract.

SANITARY FIXTURES

1.0 SCOPE OF WORK

Comply with General Requirements and all documents referred to therein.

Provide and install all sanitary fixtures as indicated on the Drawings and as specified.

Without restricting to the generally of the foregoing, the work shall include the supply, erection, installation, testing and commissioning of chinaware sanitary fixtures complete

including all appliances and connecting accessories to make it completely functional to the satisfaction of the Engineer in charge.

2.0 FIXTURES

2.1 EUROPEAN W.C.

European W.C. shall be floor mounted set, flushed by means of flushing cistern as specified in Schedule of Quantities and as shown in the drawings. Flush pipe/bend shall be connected to the W.C. by means of suitable rubber adapter.

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

Orissa pan type WC shall be fixed as per specifications in the Schedule of Quantities.

The flushing cistern shall be low level type (porcelain/thin wall HDPE or other plastics type connected to the W.C. by means of a 32 mm dia. flush pipe and connected to the WC pan with a compatible rubber adapter.

The cistern shall be provided with all internal fittings & ball cock, to be a complete working cistern.

The flushing cistern shall be only those which are fully compatible for use for its flow and flushing characteristics with the particular type of WC of specific manufacture and approved and accepted for fixing by the WC fixture manufacturer.

The flush pipe shall be chromium plated when exposed inside the bathroom and GI (IS 1238 Medium class) when concealed in wall chase or shaft.

2.2 WASH BASIN

Wash Basins shall be white glazed vitreous china of size, shape and type as specified in the Schedule of Quantities.

Each Basin shall be provided with R.S. or C.I. brackets and clips and the basin shall be securely fixed to wall. Placing of Basins over the brackets without proper securing and fixing shall not be accepted.

Each Basin shall be provided with 32mm dia C.P. waste with overflow, 32mm dia C.P. Brass Bottle Trap with C.P. pipe to wall with flange as given in the Schedule of Quantities.

Each basin shall be provided with cold water taps or sensor operated faucets or mixing fitting as specified in the Schedule of Quantities.

2.3 URINALS

Urinals shall be white glazed Vitreous China flat back half stall or lip type as specified in Schedule of Quantities.

Half stall Urinals shall be provided with 15 mm dia C.P. spreader, 32 mm dia C.P. domical waste and C.P. brass bottle trap with C.P pipe to wall with flange, and shall be fixed to wall by one C.I. bracket and two C.I. wall clips as recommended by manufacturers complete and as directed by Engineer-in-Charge.

Half stall urinals shall be fixed with C.P. Brass screws and shall be provided with 32 mm dia Domical Waste leading to Urinal trap.

Urinals shall be flushed by means of auto operated overhead cistern flushing system as specified in Schedule of Quantities.

Urinal partitions shall be of white glazed vitreous china or 25mm thick marble of size as specified in the Schedule of Quantities.

Porcelain partitions shall be fixed at proper heights with C.P. brass bolts, anchor fasteners and M.S. clips as recommended by the manufacturer and directed by Engineer-in-Charge.

2.4 ACCESSORIES

Contractor shall install all Chromium Plated and porcelain accessories as shown on the drawings or as directed by Engineer-in-Charge and given in the Schedule of Quantities.
All C.P. accessories shall be fixed with C.P. brass half round head screws and cup washers in wall with rawl plugs or nylon sleeves and shall include cutting and making good as required or directed by Engineer-in-Charge.

Porcelain accessories shall be fixed in walls and set in cement mortar 1:2 (1 cement: 2 coarse sand) and fixed in relation to the tiling work.

2.5 MEASUREMENT

Rates for fixing of sanitary fixtures, accessories, urinal partitions shall include all items and operations stated in the respective specifications and Schedule of Quantities and nothing extra is payable.

Rates for all items with the above specifications shall be inclusive of cutting holes and chases and making good the same including all C.P. screws, nuts, bolts and any fixing arrangements required and recommended by the manufacturer including testing and commissioning.

SOIL, WASTE, VENT & RAIN WATER PIPES

1.0 SCOPE OF WORK

a. Without restricting to the generally of the foregoing the soil, waste, vent pipe and rainwater system shall include the following:-

b. Vertical and horizontal soil, waste, vent pipes and rainwater pipes and fittings, joints, supporting clamps and connections from fixtures.
c. Connection of sewer line to external sewerage system.
d. Connection of drainage water (from lower basement by pumping) to external storm water drain.
e. Rain water harvesting.
f. Floor traps, floor drain, cleanout plugs.
g. Waste pipe connections from all fixtures i.e. wash basin, urinal etc.
h. Testing of all the pipes and commissioning of the system.

2.0 GENERAL REQUIREMENTS

All the soil, waste and vent pipe shall be centrifugally cast (spun) iron pipes conforming to I.S:3989.

All the rain water pipes shall be UPVC pipes (UV stabilized) as per IS 13592.

All materials shall be new of the best quality conforming to specifications and subject to the approval of Engineer-in-Charge.
Pipes and fittings shall be fixed truly vertical, horizontal or in slopes as required in a neat workmanlike manner.
Pipes shall be fixed in a manner as to provide easy accessibility for repair and maintenance and shall not cause obstruction in shafts, passages etc.
Pipes shall be securely fixed to walls and ceilings by suitable clamps at intervals specified.

Access doors for fittings and cleanouts shall be so located that they are easily accessible for repair and maintenance.
The material being selected shall withstand the design conditions specified in this specification.
All works shall be executed based on norms and good engineering practice and as directed by Engineer-in-Charge.
All pipes shall be straight and smooth and inside free from irregular bore, blowholes, cracks and other manufacturing defects. Pipes shall be centrifugally cast (spun) iron pipes conforming to I.S:3989 as specified in Bill of Quantities.

2.2 uPVC FITTINGS

Fittings with solvent joint shall and the Contractor shall use pipes and fittings of matching specifications.

Fittings shall be of the required degree of curvature with or without access doors as per requirements.

uPVC fittings i.e. elbow, tee, reducer, caps with socket end suitable for solvent cement jointing shall confirm to IS 7834.

2.3 FIXING

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

Horizontal pipes shall be laid to uniform slope and the clamps adjusted to the proper levels so that the pipes fully rest on them.

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

2.4 TRAPS

Floor traps shall be of single/multi-outlet cast iron trap with minimum effective seal of 50 mm. The trap shall have 75/100mm dia. outlet with none/one/two/three inlet connections of 32mm dia. or 40mm dia. or 50mm dia. to receive the waste pipe from sanitary appliances as per standard practice. GI hopper pipe of 100mm dia. to be lead jointed above the floor trap and inlet sockets to be welded to the hopper as per inlet requirements. The type of trap based on the diameter of the inlet connections at site may be selected as per site requirements. The trap and waste pipes shall be properly supported.

2.5 C.P./STAINLESS STEEL GRATING

Floor drain, Floor trap and Urinal Traps shall be provided with 100-150 mm square or round C.P/Stainless steel grating, with rim of approved design and shape. Minimum thickness shall be 4-5 mm or as specified in the schedule of quantities.

2.6 CLEANOUT PLUGS

Contractor shall provide uPVC cleanout plugs at the terminal ends of horizontal branch lines. Cleanout plugs shall be threaded and provided with key holes for opening.

2.7 WASTE PIPE FROM APPLIANCES

Waste pipe from appliances e.g. wash basins, urinals shall be of GI pipes as given in the schedule of quantities and as shown on the drawings.

All pipes shall be fixed in gradient towards the outfalls of drains. Waste pipes inside a hang in ceiling below in suitable gradient as shown in the drawings. The waste pipes along ceiling may be supported on structural clamps as per requirements.

2.8 CEMENT CONCRETE

All Soil and Waste pipes under floor in ground level shall be encased in all around cement concrete 1:2:4 mix (1 cement: 2 coarse sand: 4 stone aggregate 12 mm size) with 75 mm thick PCC bed.

2.9 INSPECTION & TESTING

INSPECTION

Work should be properly inspected during installation and testing should be done for each and every section of the installation. Care must be taken to ensure that all work are tested before it is finally concealed.

Inspection should be carried out to ensure the following:

i. Work accords with the drawing and specifications.
ii. All pipe brackets, clips etc. are securely fixed.
iii. Fixtures are correctly spaced.
iv. Pipe is protected where necessary by thermal Insulation.
v. Embedded pipe work is properly protected before sealing-in.
vi. All access covers, caps or plugs are accessible and approachable.

TESTING

The soil, waste piping system and rain water should be tested after installation as follows:

Water Testing

The pipes shall be tested after installation & before the appliances are connected, preferably in sections so as to limit the static head of 4.5m. The pipe shall be filled with water for at least 10 minutes. After filling, pipes shall be inspected for holes and cracks. All defective pipes shall be rejected and removed from the site.

Smoke Testing

The Contractor may also test all Soil, Waste and Rainwater stacks by smoke testing machine. The smoke test shall be carried out as under:

Smoke shall be pumped into the stack after plugging all inlets and connections at the required points from a smoke testing machine which consists of a bellow & burner. The material usually burnt is greasy cotton waste which gives out a clear pungent smoke which is easily detected by sight as well as by smell, if there is leak at any points of the pipe. The stack shall then be observed for leakness and all defective pipes and fittings removed or repaired as directed by the Engineer-in-Charge.

A test register shall be maintained and all entries shall be signed and dated by Contractors and Engineer-in-Charge.

2.10 MEASUREMENTS

Rates for all items quoted shall be inclusive of all work and items given in the above mentioned specifications and Schedule of Quantities and applicable for the work under floor, in shafts or at ceiling level for all heights and depths.

All rates are inclusive of cutting holes and chases in RCC and masonry work and making good the same.

All rates are inclusive of pre testing and on site testing of the installations, materials and commissioning.

Pipes (Unit of measurement Linear meter to the nearest centimeter)

All the pipe shall be measured per running meter correct to a centimeter for the finished work, which shall include fittings e.g. Bends, Tees, Elbows, Reducers, Crosses, Sockets, Nipples and Nuts but exclude brass or Gunmetal Taps (Cocks), Valves etc. The length shall be taken along center line of the pipes and fittings. All pipes and fittings shall be classified according to their diameter, method of jointing and fixing substance, quality and finish.

Cement concrete around pipes shall be measured along the center of the pipe line measured per linear meter and shall include any masonry supports, shuttering and centering, cutting etc complete as described in the relevant specifications.

Slotted angles/channels shall be measured per linear metre of finished length and shall include support bolts and nuts embedded in masonry walls with cement concrete blocks and nothing extra will be paid for making good the same.

Painting: Painting of pipes shall be measured per running metre and shall be inclusive of all fittings and clamps. No deduction for fittings shall be made.

Structural Clamps: Structural clamps and U clamps shall be paid for by weight per kg. Rates shall be inclusive of all nuts, bolts, drilling, cutting, welding. Weight of clamps shall be calculated from the actual length used in structural members multiplied by its theoretical weight given in manufacturers catalogues. Weight of nuts, bolts, shall not be taken into account. M.S holder bats for holding upVC pipes in walls shall not be measured separately and it shall be a part of fixing uPVC pipes.

Excavation for soil pipes: No extra payment shall be admissible with respect to excavation, refilling and disposal of surplus earth for soil and waste pipes.

WATER SUPPLY SYSTEM

1.1 WORK INCLUDED

Comply with General Requirements and all documents referred to therein.

Provide and install all valves as indicated on the Drawings and as specified.

1.2 SUBMITTALS

Shop Drawings and Product Data:

Refer to General Requirements for procedure and additional submittal requirements.

Furnish shop drawings and product data for valves.

1.3 SCOPE OF WORK

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

24. Water Supply from bore well to domestic storage tank via overflow arrangement from fire fighting storage tank.
25. Tapping municipal main and supply to storage tanks.
26. Domestic pump and pumping line to storage tanks.
27. All down feed water distribution lines to toilets and wet areas and making connection from main down take line etc.

28. Isolation/Pressure Reducing valve, water meter, etc.
29. Pipe protection and painting.
30. Control and Safety valves, masonry chambers and other appurtenances.
31. Connections to all toilets, wet areas and appliances.
32. Excavation and refilling of pipe trenches, wherever necessary.

2.0 GENERAL REQUIREMENTS

All the water supply and down feed distribution water lines shall be heavy duty, Class C/, medium, Class-B- Galvanized Iron pipes as per the specifications.

All materials shall be new of the best quality conforming to specifications. All works executed shall be to the satisfaction of the Engineer-in-Charge.

Pipes and Fittings shall be fixed truly vertical, horizontal or in slopes as required in a neat workmanlike manner.

Pipes shall be fixed in a manner so as to provide easy accessibility for repair and maintenance and shall not cause obstruction in shafts, passages etc.

Pipes shall be securely fixed to walls and ceilings by suitable clamps at intervals specified.

Valves and other appurtenances shall be located so as to provide easy accessibility for operations, maintenance and repairs.

2.1 G.I. PIPES & FITTINGS

All pipes inside the buildings and where specified, outside the building shall be galvanized steel tubes conforming to I.S. 1239 heavy grade, C class/medium, Class-B

Fittings shall be malleable iron galvanized fittings, of approved make. All fittings shall have manufacturer's trade mark stamped on it. Fittings for G.I. pipes shall include Couplings, Bends, Tees, Reducers, Nipples, Unions, and Bushes. Fittings shall be of IS:1879 - (part I to X).

Pipes and fittings shall be jointed with screwed fittings. Care shall be taken to remove burr from the end of the pipe after cutting by a round file. Genuine red lead with grumet and a few strands of fine hemp shall be applied. All pipes shall be fixed in accordance with layout and alignment shown on the drawings. Care shall be taken to avoid air pockets. G.I. pipes inside toilets shall be fixed in wall chases well above the floor. Pipes may run under the ceiling or floors as shown in the drawings.

2.2 CLAMPS

G.I. pipes in shafts and other locations shall be supported by M.S. clamps of design approved by Engineer-in-Charge. Pipe in wall chases shall be anchored by iron hooks. Pipes at ceiling level shall be supported on structural clamps fabricated from M.S. structural as per approval of the Engineer-in-Charge. Pipes in typical shafts shall be supported on slotted angles/channels as specified elsewhere.

2.3 UNIONS

Contractor shall provide adequate number of unions on all pipes at required locations for isolating sections for maintenance. Unions shall be provided near each Gunmetal Valve, Stop Cocks, or Check Valves and on straight runs as necessary at appropriate locations as required and/or directed by Engineer-in-Charge.

Unions are to be provided on pipes lines 50 mm and below, near valves and assemblies and as required as per site conditions.

2.4 FLANGES

Flanged connections shall be provided on pipes wherever shown in the drawings including all equipment connections as necessary and required or as directed by the Engineer-in-Charge. Connections shall be made by the correct number and size of the bolts and made with 3 mm thick insertion rubber washer. Where hot water connections are made insertion gasket shall be of suitable high temperature grade and quality approved by Engineer-in-Charge.

Flanges shall be provided on straight runs not exceeding 12-15 m on pipe lines 80 mm dia and above.

Flanges shall be provided on for jointing all types of valves, appurtenances, pumps, connections with other type of pipes, to water tanks and other places necessary and required as good for engineering practice.

Flanges shall be as per ASME/ANSI B16.5 with appropriate number of G.I. nuts and bolts, 3 mm insertion rubber gasket complete.

All couplings and fittings shall be provided by a single source supplier.

2.5 VALVES

2.5.1 GENERAL

- Provide valves of same manufacturer for all plumbing systems, including valves furnished with equipment.

- For flanged valves, provide companion flanges of same PSI rating/class of valve being used.

- Provide all valves rated not less than 10kg/cm2 working pressure for plumbing systems unless indicated otherwise.

- Provide valve materials suitable for service and temperature of respective systems.

- Provide valves at points shown and as required for complete isolation of equipment, branches from the main lines, arranged so as to give complete and regulation control of piping systems throughout the building. Install valves, with neat appearance and grouping, so that all parts are easily accessible for maintenance.

- Provide valves as per specifications below and as per schedule of quantities. Valves for similar service shall be of one manufacturer including valves furnished with equipment.

- Wheel handles to be non-heating style cast from malleable iron ASTM A197.

- Mark each valve at the factory with the following minimum information, engraved, stamped or cast on each valve or metal tag permanently attached to the valve.

- Manufacturer's name.
- Catalog or Figure number.
- Size and pressure class.

- Arrows shall indicate direction of flow on check, globe, angle, non-return and eccentric plug valves.

- Valves for plumbing services shall be ISI marked.

- Generally, all the valves upto 50mm dia shall be of gunmetal/bronze body with screwed ends and shall be provided with unions on both the sides for removal and repair, unless instructed otherwise.

- Generally, all the valves above 50mm dia shall be of CI body with flanged ends and shall be provided with flanges on both the sides for removal and repair, unless instructed otherwise.

- Provide valves on all main branches of water supply as specified in the drawings or as per site requirements. Provide all valves, check valves, PRV, strainers of same size as the pipes in which they are installed unless otherwise indicated.

- Wherever possible, install valves accessible from floor level. Provide operating handles for all valves and cocks. Provide adequate clearance for easy operation.

- Face to Face dimensions of the valves shall be as per ASME/ANSI B 16.10.

2.5.2 BALL VALVES

Ball Valves shall be of IS 9890, Gun metal with screwed female ends to IS 554, flanged ends to ASME B 16.5.

Provide full bore, quarter turn, lever operated ball valves with S/S ball and SS(AISI 410) spindle with Teflon seating and gland packing. All ball valves shall have locking handles to allow servicing and removal of equipment.

Provide lever handle with plastic sleeve on all ball valves unless otherwise noted. Provide extension stem for all ball valves to be installed on insulated piping.

2.5.3 CHECK VALVES

Check valves of size 40mm or less shall be as per IS 778 and of size 50mm or more shall be as per IS 780. The screwed female ends shall be to ASME B 16.11 and flanged ends shall be to ASME B 16.5.

All check valves 50mm and smaller shall be of bronze body and disc, threaded ends or as required by the piping system in which they are installed.

All check valves 65mm and larger shall be of cast iron body with epoxy coated ductile iron/ stainless steel trim and shall be of flanged end as required by the piping system in which they are installed.

All check valves shall be spring loaded, silent or non-slim type.

2.5.4 BUTTERFLY VALVES

All valves 80mm dia and above shall be Butterfly valves, unless otherwise specified.

Butterfly valves shall be of best quality conforming to I.S 13095 of class specified.

Provide Wafer type C.I. double flanged butterfly valves of required sizes and of rating as mentioned in schedule of quantity.

Butterfly valves shall be high performance valves manufactured of Cast iron/ Ductile Iron body, epoxy coated ductile iron / 316 stainless disc and stainless steel stem with EN-8/ SS-410 shaft.

Joints for double flanged butterfly valves shall be made with suitable tail/socket pieces on the pipeline and flanges joints made with appropriate number of bolts, nuts and washers with 3 mm thick insertion rubber gasket.

Provide the following butterfly valve accessories:

Valves 200 mm or larger shall have gear operator with crank handle or hand wheel.

Valves smaller than 150 mm shall have nine position levers.

Where valves are located 2 m above floor level in equipment rooms provide chain wheel operators and chains.

Provide a position indicator on all butterfly valves.

For valves without full access provide enclosed extension stems to allow operation.

for installation of pressure gauge.

2.5.5 AIR RELEASE VALVES

Air release valves shall be single acting type air valves with cast iron body and bronze/gunmetal internal parts and plastic float.

Each air release valve shall be provided with a cast iron isolating sluice valve of specification given above.

2.5.6 SCOUR VALVES

Scour valves shall be with cast iron body with flanged connections.

2.6 VALVE CHAMBERS

Contractor shall provide suitable brick masonry chambers in cement mortar 1:5 (1 cement: 5 coarse sand) on cement concrete foundations 150 mm thick 1:5:10 mix (1 cement: 5 fine sand: 10 graded stone aggregate 40 mm nominal size) 12 mm thick cement plaster inside and outside finished with a floating coat of neat cement inside with cast iron surface box as approved or as specified in Schedule of Quantities and in drawings including excavation, back filling complete.

2.7 TRENCHES

External water supply galvanized iron pipes and fittings shall be laid in trenches. The width and depth of the trenches for the different diameters of the pipes shall be as follows:

Dia of Pipe	Width of Trench	Depth of Trench
15mm to 50mm	30 cms	60 cms
65mm to 100mm	45 cms	75 cms

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 earthwork in trenches.

When excavation is done in rock, it shall be cut deep enough to permit the pipes to be laid on a cushion of sand minimum 7.5 cm deep.

2.8 PAINTING

All pipes above ground shall be painted with one coat of Red Lead and two coats of Synthetic Enamel paint of approved shade and quality. Pipes shall be painted to standard colour code specified by Engineer-in-Charge.

All pipes in chases and below floor shall be provided Anti-corrosive treatment.

2.9 TESTING

All pipes, fittings and valves shall be tested by hydrostatic pressure of min. 1.5 times the working pressure and subject to minimum of 7 kg/cm2 in any case and with the consent of Engineer-in-Charge.

Pressure shall be maintained for a period of at least two hours without appreciable drop in the pressure after fixing at site. (+10%). A test register shall be maintained and all entries shall be signed and dated by Contractor(s) and Engineer.

In addition to the sectional testing carried out during the construction, Contractor shall test the entire installation after connections to the overhead tanks or pumping system or mains. He shall rectify all leakages, and shall replace all defective materials in the system. Any damage done due to

carelessness, open or burst pipes or failure of fittings, to the building, furniture and Fixtures shall be made good during the defects liability period without any extra cost.

After completion of the water supply system, Contractor shall test each valve by closing and opening it a number of times to observe if it is working efficiently. Valves which do not effectively operate shall be replaced by new ones at no extra cost and the same shall be tested as above.

Test valve bonnets for tightness. Test operate valves from closed-to-open-to-closed position while valve is under test pressure.

Test automatic valves including solenoid, pressure relief valves, safety valves and temperature and pressure relief valves for proper operation at settings indicated.

Ensure that valves are field checked for packing and lubricated.

Test all valves, air relief valves, safety relief valves, safety valves and temperature and pressure relief valves three times.

3.2 MEASUREMENT

Pipes shall be measured per linear metre (to the nearest cm) and shall be inclusive of all fittings e.g. couplings, tees, bends, elbows, unions, deduction for valves shall be made, cutting holes chases and making good the same and all items mentioned in the specifications and Schedule of Quantities.

Gunmetal and cast iron valves shall be measured by numbers.

Painting for Pipes and over insulation shall be measured per linear metre over finished surface and shall include all valves and fittings for which no deduction shall be made.

3.3 DISINFECTION

After completion of the work Contractor shall flush clean the entire system with the filtered water after connection has been made.

After the first flushing, commercial bleaching powder is to be added to achieve a dosage of 2 to 3 mg/l of water in the system added and flushed. This operation should be performed twice to ensure that the system is fully disinfected and usable.

DRAINAGE & SEWERAGE SYSTEM

1.1 WORK INCLUDED

Comply with General Requirements and all documents referred to therein.

Provide and install all valves as indicated on the Drawings and as specified.

1.2 SUBMITTALS

Shop Drawings and Product Data:

Refer to General Requirements for procedure and additional submittal requirements.

Furnish shop drawings and product data for valves.

1.3 SCOPE OF WORK

Without restricting to the generality of the foregoing, the sewerage and drainage system shall include:

- Internal/External sewer lines and drain channel at lowest basement and at ground level. Drain points at first and second basement level and down takes to drain channel/drainage sump at lowest basement.
- Drainage sump pump delivery to external ground level drainage system.
- Subsoil drainage system over basement and disposal to external drainage system.
- Storm Water Drainage system and Rain water harvesting including bypass / interconnections and connection/disposal to external drainage system.

2.0 GENERAL REQUIREMENTS

The drain pipe for sub soil drainage will be upper half perforated and bottom half embedded in the surrounding concrete and laid in a specified slope and surrounded all along with geo-textile filter layer and pebble/gravel/sand as per site requirements.

All the external sewer lines shall be CI LA/RCC pipes unless specified otherwise.

All materials shall be new of the best quality conforming to specifications and subject to the approval of the Engineer-in-Charge.

Surface drainage channels shall be laid to the required gradients and profiles as shown in the drawings.

All drainage work shall be done in accordance with the local Municipal byelaws.

All works shall be executed as per the directions of the Engineer-in-Charge.

3.0 ALIGNMENT AND GRADE

The drainage pipes shall be laid to alignment and gradient shown on the drawings but subject to such modifications as shall be ordered by the Engineer-in-Charge from time to time to meet the requirements of the works. No deviations from the lines, depths of cutting or gradients shown on the plans and sections shall be permitted except by the express direction in writing of the Engineer-in-Charge.

3.1 MEASUREMENT

Pipes shall be measured for the finished length of the pipe line per linear metre. Rate shall include all items given in the Schedule of Quantities and specifications.

Item for making connection to external sewer line shall be paid for by number and shall include all items given in the Schedule of Quantities and Specifications.

Brick Masonry and Cement Concrete shall be measured as given in the Schedule of Quantities.

3.2 TESTING

All lengths of the sewer and drain shall be fully tested for water tightness by means of water pressure maintained for not less than 30 minutes. Testing shall be carried out from manhole. All pipes shall be subjected to a test pressure of at least 1.5 meter head of water. The test pressure shall, however, not exceed 1.5 metre head at any point. The pipes shall be plugged preferably with standard design rubber plugs on both ends. The upper end shall, however, be connected to a pipe for filling with water and getting the required head.

The Contractor shall give a smoke test to the drains and sewer at his own expense and charges, if directed by the Engineer-in-Charge.

A test register shall be maintained which shall be signed and dated by Contractor, Engineer-in-Charge and representative of Architects/ Consultants.

3.3 OTHER SERVICES

Contractor shall take the necessary precautions avoid the damage to other services such as water supply lines, telephone cables, electrical cables, storm water drains etc. in case of any damages to any of the services, contractor shall be responsible for restoring the facilities in bare minimum time at his own cost.

PLUMBING IDENTIFICATION

1.1 WORKS INCLUDED

Comply with Schedule of Quantity, General Requirements and all documents referred to therein.

All piping and ductwork concealed or exposed shall have identification markers. All equipment and system components shall have identification markers. Relocate mechanical identification material and devices that have become visually blocked by works of this Division or other Divisions.

1.2 SUBMITTALS

Submit shop drawings as product data under provisions of General Conditions, Schedule of Quantities.

Submit samples of all application sample, valve schedules, equipment schedules, etc. for review by the Engineer.

Submit nomenclature system for all valves, equipment, etc. for review.

Submit copy of all valve schedules, piping lists, and equipment list with Operating and Maintenance Manuals.

1.3 COMPLIANCE

Proper identification for system and equipment where required by codes, regulations, authority's requirements.

2.0 PRODUCTS

2.1 MANUFACTURER'S IDENTIFICATION

Manufacturer's nameplate, catalog numbers, rating identification, name or trademark shall be permanently affixed with screws or rivets (adhesives or cements are not acceptable) to all equipment and material furnished under this specification.

Identify model number, size, capacity, electrical characteristics, serial number, etc.

Leave nameplates clean, legible and with unobstructed view.

2.2 PIPE IDENTIFICATION

Identify with symbol identification and color-code all piping. Provide directional arrows on circulating systems separate from and adjacent to each identification. Identification in conformance with ANSI13.1 or with the relevant IS standards.

Color Coding: The following color coding or as directed by the engineer in charge shall be used

Service	**A. S. A. Color background**	**Color Of Letter**	**Designation**
Domestic Cold Water	Green	White	DCWS

Service	A. S. A. Color background	Color Of Letter	Designation
Sanitary Sewer	Green	White	
Sanitary Sewer Vent	Green	White	
Rainwater Leaders	Green	White	

2.3 VALVE IDENTIFICATION

Provide valve tags for all valves. Attach to hand wheel or stem of each control and line shutoff valve installed under this Division, with heavy brass "S" hook, color-coded plastic laminate or brass identification tag. Engrave laminate tags shall be at least 25 mm in diameter with numerals at least 3 mm thick. Tag all valves except fixture stops.

3.0 EXECUTION

3.1 PREPARATION

Degrease and clean surfaces to receive adhesive for identification materials of any materials that will prevent paint to marker adhesion.

3.2 EQUIPMENT IDENTIFICATION

Properly identify each piece of equipment and controls pertaining thereto by nameplates mounted on equipment and controls using round head brass machine screws or pop rivets. Cardholders in any form not acceptable.

Apply with sufficient adhesive to ensure permanent adhesion and seal with clear lacquer.

Place warning signs on machines driven by electric motors which are controlled by fully automatic starters.

Identify air handling units, fans and pumps with area served.

Small devices, such as inline pumps, may be identified with tags.

Identify control panels and major control components outside panels with plastic nameplates.

Identify equipment out of view behind access doors, in unfinished rooms on the face of the access door.

3.3 PIPING IDENTIFICATION

Apply markings after all cleaning and painting of piping and insulation is completed.

Location for Pipe Identification:

At each branch and riser takeoff.

At each pipe passage through wall, floor and ceiling construction.

On all horizontal runs spaced 6 m maximum but not less than once in each room at entrance and exit of each concealed space.

Where capped piping is provided for future connections, provide legible and durable metal tags indicating symbol identification.

At wall and ceiling access panels.

In addition to foregoing identification for piping, identify fire protection piping with 25 mm wide red painted band, completely encircling pipe adjacent to symbol identifications.

Install plastic pipe markers in accordance with manufacturer's instructions.

Install plastic tape pipe markers complete around pipe in accordance with manufacturer's instructions.

Install underground plastic pipe markers 150 mm to 200 mm inches below finished grade, directly above buried pipe.

In finished areas, label exposed pipes or ducts only adjacent to walls.

3.4 VALVE IDENTIFICATION

Valve Identification tags shall have the abbreviations plus valve number.

Identification shall be black lettering on white background or in a manner approved by the Engineer.

LIST OF APPROVED MAKE FOR P.H.E. WORKS

Sl. No.	Equipment/ Material	Acceptable Supplier/ Manufacturer
1.	VITREOUS CHINA SANITARYWARE	PARRYWARE, HINDWARE, CERA, NEYCER
2.	C.P FITTINGS	JAQUAR, GEM,
3.	C.P BOTTLE TRAP	KINGSTON, PARKO
4.	G.I. / M.S. PIPES	TATA, JINDAL (HISAR)
5.	G.I FITTINGS	UNIK /S.S/SAINT

Sl. No.	Equipment/ Material	Acceptable Supplier/ Manufacturer
6.	SWR PIPES AND FITTING	SUPREME, FINOLEX, PARKASH
7.	C.I PIPES & FITTINGS	NECO/ HEPCO/ RIF
8.	STONEWARE PIPES & GULLY TRAPS	PERFECT, KESORAM, BURN
9.	R.C.C HUME PIPES	INDIANHUMEPIPE, JKSPUN, PRAGATI CONCRETEUDYOG / K.K
10.	GUNMETAL VALVE (FULL WAY VALVE)	ZOLOTO, LEADER
11.	BALL VALVE	LEADER/ ZOLOTO/ CIM
12.	C.I. SLUICE VALVE	AUDCO/ IVC/ KIRLOSKAR,
13.	FLOAT VALVE (GUNMETAL)	LEADER, SANT
14.	SFRC GRATING/MANHOLE COVER	KK MANHOLE Or Equivalent
15.	PLUMBING WORK AGENCY	SEM RISK SOLUTION / MEP CONTRACTOR AND ENGINEERS / K.K.infra
16.	WATER METER	KAPSTAN/ KRANT/ ANAND
17.	GRATING FOR FLOOR TRAP & FLOOR DRAIN	CHILLY OR EQUIVALENT
18.	CENTRIFUGAL PUMPS/SUMP PUMP	KSB/ GRONDFOS/ KIRLOSKAR/ CROMPTON
21.	LEVEL SENSOR & INDICATORS	ABB KENT TAYLER/ LEVCON/ S.B. ELECTROMECH
22.	PRESSURE GAUGE	FIEBIG/ HGURU
24.	PVC RAIN WATER PIPES / FITTING	SUPEREME/ FINOLEX , PARKASH
25.	BALL VALVE	LEADER/ ZOLOTO
26.	OVERHEAD HDPE WATER TANK	SINTEX/ POLYWELL/ ROTEX

Sl. No.	Equipment/ Material	Acceptable Supplier/ Manufacturer
27.	NON-CLOG CENTRIFUGAL PUMPS	JHONSON/ KIRLOSKAR
28.	TURBINE PUMP	JYOTI / KSB/ WORTHENGTON
29.	SUBMERSIBLE PUMP	KSB/ GRUNDFOS/ KISHORE
30.	MOTORS	KIRLOSKAR/ SEIMENS/ NGEF/ CROMPTON

TECHNICAL SPECIFICATION FOR AUTOMATED CAR PARKING SYSTEMS

I. General Description and criteria

A. <u>Automated Parking System Capacity (Vehicle storage spaces):</u>

Tower modules(Entry Exit points)	2
PARKING LEVELS PER TOWER	17
SLOTS PER TOWER	34
Gross parking spaces	**68**

Gross parking spaces are the total number of developed spaces in the garage. The cost of the installed system shall be based on the gross spaces because each space should be fully developed and serviced by the automated parking equipment.

B. <u>Vehicle overall Length Measurement Limits</u>: Equipment shall confirm to suit and should be the stall/ frame sizes suitable to Vehicle overall measurement Limits. The vehicle measurements shall be governed by details of specifications.

Maximum over all dimensions of park able cars should be 5.1M in length, 2.1M in width and 2.0M in height, i.e. the proposed system should be capable of handling all types of cars used in India.

C. Weight Capacity

The proposed system should be designed to accommodate a maximum vehicle load of 2,500 kg. Dynamic testing of the system shall be conducted in accordance to standard EN14010 with a total load of 2,750Kg. The designed parameter s should coverall most all types of cars that will fit into the parking system given the limits of the structure.

D. Description of Basic components of proposed automated car Parking System:

1. **Proximity Card Issue and Reader:** It is a device used to enter the required service at parking side it will read parking requirements, enters data on the proximity card, issues the card and initiates the parking activity. For a regular user it reads the proximity card and initiates the parking activity. At Exit end it reads the data from proximity card and initiates retrieval activity.

2. **Entry Automatic Access Gates or Barrier:** On initiation it automatically opens, allows the car to enter the entry lobby, on exit of user and receiving the instruction from car reader it closes automatically. It should have sensor to monitor exit function of user and it should not close in any case leaving the user inside the entry lobby/ lift.

3. **Entry lobby/ Elevator bay:** This is a location up to where user is allowed to enter with car, park the car and leave. This lobby is online monitored, having all proximity sensors, infra-red sensors and other controls. The lobby is accessible to car lifting and car transfer pallet.

4. **Entry access Gates to Vertical Transporter:** On departure of user from entry lobby and on closing of entry barrier, Elevator mounted pallet and car moves vertically to the appropriate parking level. It should operate on sensor and lock based PLC control system. It operates vice versa on retrieval time; it allows the car to be brought into the exit lobby and closes once car is out of exit. In any case, it should not close when user is within entry or exit lobby.

5. **Elevator:** This is the electro mechanical equipment, which used to for vertical transportation of car along the vertical pit and hosts the pallet for car transfer. This transports the car and pallet or only pallet to appropriate level car placement or retrieval.

7. **Pallet:** This is the equipment which holds the car while it's being placed in horizontal parking spaces on either sides of the elevator pit. The pallet holds the car and therefore keeps it secured in position within its base area while being placed in the parking slot or during vertical transfer. Within the parking tower, the car is always placed on the pallet. This can only be operated when the elevator mounts it. At any time during normal operation, the number of pallets is at least equal to number of parking slots in the tower (although extra pallets should be kept as a contingency in case of breakdown).

8. Parking Slots/ frames: These are the defined locations with guide rails/ frame for parking the cars with pallets, or the empty pallet only. In any case, all the slots are occupied with pallet when the elevator in not in operation.

E. <u>Automated Parking System Processing Capacity</u>:

The minimum throughput should be calculated as per table, in or out, under continuous operation. User time is assumed to be 45 sec. Following the allowance/steps required for fixed users by German standard VDI 4466. :

The complete Vehicle Parking cycle shall consist of three steps:

Entrance Cycle
Vertical transfer
Horizontal transfer

The complete vehicle Retrieval cycle consist of three steps:

Horizontal transfer
Vertical transfer
Exit transfer
Under the conditions set above, each, Vertical and Horizontal transfer should Need less time compared to Entrance or exit cycles so the last two only are critical and are considered to determine the maximum throughput.

Entrance single cycle under continuous operation (Entrance peak hour)	
User time (starting when automatic barrier is open and Ending when operation is started by the user)	45 Sec
Opening door	5 Sec
Transferring the car to the Elevator	23 Sec
Closing Door and Opening barrier	5 Sec
Transferring car to the parking place And return to receive the next car	42 Sec
(Same time will be used for entry of next car)	
Total cycle time	120 Sec
Maximum single entrance cycle time:	120
Number of vehicle stored in one hour:	3600/120 = 30
Total Number of vehicles stored in one hour:	30 x 2= <u>60</u>

In the same way, the retrieval single cycle under continuous operation (Exit Peak Hour) should be 120 seconds and the total number of vehicles retrieved in one hour will be 60 cars.

The retrieval time related to the farthest car in second bay will be less than 3 minutes.

F. <u>Facility Operations shall be continuous</u>

The proposed automated parking system should be designed and able to operate continuously and be available for 24 hours per day, 7 days per week. (Regular maintenance should be done at night hours, i.e. no operation time)

G. Vehicle Entry/ Exit and access lanes

The access lanes are shown in the architectural drawings. Attention shall be paid by the contractor in order to make easy and accurate the access or exit of any one of the entrance/exit areas for one for each elevator.

Vehicle Breakdowns

The contractor / operator do not have any control over a vehicle that might become disabled in the driving lanes. In This event the on- site staff will have to be immediately assisting in removing the vehicle from the travel way. A battery charger and a compressor with air gauge should be available at the entrance level.

H. Patron Storage and Retrieval

System access and egress should be a straight forward activity, not unlike delivering ones car to a valet or a normal parking operation. Drivers access the entrance transfer area through an automatic barrier set which, during the entrance peak hour and under the condition that the entrance transfer area is free, is open while the traffic light is green. They park the car in the entrance transfer are following the direction of a pictographic lighted panel, proceed through the barrier gate, start the automatic parking operation and exit into the patron lobby.

Driver's re-patronization with their vehicle will be a directed event based on visual notice of the appropriate exit area and signs that clearly mark the direction.

I. Proximity card loss

Proposed car parking mechanism should be designed to retrieve the car even in case of loss of proximity card. In case of loss of the personal proximity card, Users will refer to the operator to retrieve their vehicles on semi-automatic mode through the PC, based on the number of the proximity card. A data base with users ID and related card number will be available on the PC system having provision to recognize the vehicle with the help of vehicle number.

J. Overweight Vehicles

Considering the standard weight of Indian vehicles, parking of overweight vehicles should never occur. However, if a vehicle is loaded to the point that it exceeds the capacity of the system, **the system** should not permit the user to complete the access routine and the vehicle shall be driven out.

K. Oversized vehicles

Oversized vehicles should be detected at automatic entry gate/ barrier and should be driven out.

L. Automated system failure

In the event there is a failure of an element of the automated system the effected entrance/ exit area would be closed by the on- site operator. However, the design of the system anticipates its continuing operation in the event of most faults as a result of the redundancy built into the system. In the event of a fault the on-site technician/ engineer should be immediately dispatched to rectify the problem

and, in any cases, it should have no effect on the continuous operation of the system.

The system should be designed with elevator and pallets which enhance the performance of the system and provide redundant devices to park and retrieve vehicles. The on- site technician will immediately assess the situation return the system to operation without delay. In the event the time to make the repair is extended for any reason the on-site technician will attempt to manually relocate the faulty equipment/ parts to where it has minimal or no impact on the operation of the system.

M. Control Rooms

Storage, Maintenance and control Rooms are shown on the lobby layout.

N. Description of System Components

The proposed system should be a combination of Vertical Transporter and transfer pallets with slots for each parking space (that has no moving parts in any of the parking spaces). Vehicles are to be transported to and from the entrance and exits and parking spaces by automated system that picks and holds the vehicle safely and securely from under of the tires and place it in its individual storage space on static guide rails.
The designed service life of the system, with minor overhauls, should be 25 years.
The proposed system should consist of Entrance and exit devices, Vertical Transport systems (VTS), Pallets (PLT), Electrical controls (ELEC) and parking frame improvements (FRM), all as required to make a complete system as specified .

In addition contractor should provide one set of barriers with protection rack for each entry area. Each Entrance/ Exit area will be equipped with a LED board for directing the movement of the vehicle and digital card reader to allow users to start the parking operation. The necessary monitoring, sensing and safety devices should be provided to make a complete operational system.

O (i). Operations

AS PROPOSED LIFT HOLDS THE CAR WITH PALLET TOGETHER TO MAKE SYSTEM 100 PERCENT OPERATIONALLY.

Proposed Vehicle Parking Operations

- At the entry security will carry out scanning of vehicle and inform the operator. On the readings of car details vehicles shall be directed accordingly to the parking lobby.
- On request operator will issue the smart card and directs user to vacant tower entrance bay.

- On getting token or smart card user will drive the car to entry bay. At entry bay user has to swipe card at reader. On reading the card, system will open access gates, car will be allowed driven in to entrance lobby.
- User parks the car on the elevator prepositioned already on the bay with an empty pallet/ cart and applies the hand break after moving the car onto it. Then he/she locks car and comes out of entry lobby. After exit from entrance lobby user shall swipe the card on card reader and on reading the operation, access door closes.
- Now the user is free to move out of parking complex.
- Once access doors closed, elevator will start to climb upto the designated empty slot at which the car is to be parked. Once at the slot, the elevator locks into position.
- The pallet is pushed into either left or right (as predesignated) slot by the elevator and now, the next cycle may commence.

For further operations system will show the particular used location as filled/ occupied, the elevator takes the next command and positions itself. With this parking cycle is complete and the time required is for one complete cycle is **3 minutes**.

Vehicle Retrieval operations

- For retrieving user has to swipe the card/ token on the reader. Reader shows car arrival location, so that the user can move to collect his car. On reading the details of the car to be retrieved reader initiates the retrieval operation and directs the system for retrieval.
- On reading the data from the card, system initiates automatically and directs its components to retrieve the car. Concerned elevator will move to the parked car location and locks itself. It then pulls the pallet onto it and thus the car enters the elevator.
- Elevator then executes the vertical transportation and takes the car to the ground. It locks itself and the barrier opens for the user to enter.
- Now car elevator will be ready to receive or retrieve the next car.
- Access doors of Entry and Exit Corridors, and elevator doors will be monitored by Visual sensors and controlled by computer. The barriers at elevator shall open when the user has left the entry bay. Exit lobby gate shall open when elevator is locked into the exit area. Time required for one complete retrieval cycle is max 2 minutes.

P. Vehicle Alarms

Some Vehicle alarm systems could be activated during the centering or transporting cycle. This alarm is normally of short duration, unlike when a door is forced open.

Q. Warranty/Guarantee

The contractor/ equipment supplier should confirms a 15 year comprehensive warranty after the date of commissioning on all equipment, Components, Software and any other piece of

Equipment of Technology with sue availability of spares and parts after the completion of operation and maintenance period.

SPECIFICATION DETAIL FOR PARKING EQUIPMENT AND CODAL REFERENCES

1	Design Criteria & Technical specification for car parking

Type of Operation	:	**Elevating / Vertical tower/ Built-in-Building**
The name of model/application		**Tower (transferred by pallet) Longitudinal**
Area of operation /Structure of parking lot	:	**Completely covered car parking lots which is rectangular above ground parking lot structured by metal frame**
Car sizes considered (Standard)		
Length mm	:	5100 mm maximum
Width mm	:	2040 mm maximum (including side mirror) As per site condition, the driver are strongly requested to park as vehicle mirror is folded. 1600 mm maximum(Sedan),2100(SUV)
(special notice for drivers)	;	
Height mm	:	
Weight kgs	:	2,500kg maximum
Car Slot Dimensions Length mm Width mm Height mm	 : : :	Matched with car size to be allowable to park as per vehicle size. As per site layout As per site layout As per site layout
Site Area considered		As per the site layout
Overall Height above ground	:	37750mm (including Machine Room + Pit clearance) 7500mm
Length	:	(Including exterior wall)
Width	:	7500mm
No of floors underground	:	GL + 17 floors above ground + machine room
Pit clearance	:	1500mm for Lift positioning
Opening wide of Entry/Exit station	:	Matched with site condition - Net width :Not less than 2600mm - Net height : Not less than 2300mm
Parking Slot/Floor details GL Each floor **Total Cars**	 : : :	 Entry / Exit : 1 Lift and 2 door Control Room, waiting room etc 2 steel pallets 68 cars (34 cars x 2 unit)
Type of door	:	Auto sliding or 2 up/down - Open width : 2600mm / Height : 2300mm - Motor : 0.2 -0.4 kw 50/60Hz - Speed : Max 15m / min
Steel structural work	:	According to structural calculation analysis done by consultant - IS 2062Code followed (TATA, SAIL, JINDAL) a. Wind power : 40-50m/sec b. Earthquake factor : zone III
Type of Drive System Vertical transporter (Lift) Steel Vehicle Pallet	 : : :	 Steel wire rope traction sheave and reduction geared motor drive Shifting device to store vehicle Shifting on rail by steel wheel

Speed control	:	Through inverter

Motor capacity of Lift Hoisting -	:	30-37 KW 4 Pole 50/60 Hz frequency foot mounted Max 40 -90m/min
Wire rope	:	1.5KW x 4 Pole 50/60Hz frequency foot mounted Max 18m / min
Speed(hoisting)	:	
Shifting - Chain	:	
Speed (Shifting)		
Type of Brake	:	AC-DC magnetic brake
Safety Devices		
Sensors	:	to detect human motion, scan for car dimension Stopper and side bumper
	:	Anti-collision by sensor detecting against wire rope cut Auto/ Manual mode
	:	with reset, alarm and shut down Sensor/ Encoder (or WCS)
Car	:	Alarm sensor for critical event
	:	Instruction notice to ensure proper parking Alarm light etc
support	:	-
		-
Protection from crash		
Emergency control		
Position feedback		
Double sensor		
Caution devices		
Others		
Controls / Program	:	Generating management reports such as occupancy, pattern of use, availability of car parks lots etc according to client requirement - Control Cabinet with PLC (IP 55) - Communication with touch screen
Operation panel	:	Program for emergency stop, controlling the entry and extraction operation buttons, and enables selection of manual and automatic operation modes.
Environmental factor	:	Temperature range : -12 ~ 50 degree Celsius Humidity : max 80%

Material specification	**:**	Steel sheet :JIS SS41 or IS 2062 (TATA, SAIL, JINDAL) Tube steel :JIS 663 or IS 1161 (TATA, SAIL, JINDAL) Structural beam :JIS SS41 or IS 2062 (TATA, SAIL, JINDAL) Steel for machinery part : JIS SS41 or IS 2062 or equivalent Cast steel : 4010 or equivalent or IS 1030 Fastener :F10T or IS 3575 Welding :MIG or ARC or equivalent Control system :IP 55 Surface coating : Primer 50 micron and finishe enamel coating as per supplier's option
Electrical Load	**:**	Max 40-50KW (assuming all equipment are operated at the same time) considering safety coefficient
Mode of Operation	**:**	Full automated / Semi automated / Manual
Power Supply	**:**	380/220V, 3 phases, 50/60 Hz at one point to our MCC Panel (Motor Control Center). Power supply Condition will be converted to local requirement.
Fire fighting & ventilation & Air conditioner & illumination	**:**	Necessary fire fighting and ventilation, illumination system will be provided as per existing Norms by consultant

2	Proposed system (Tower) information & Pictures

TOWER parking system (Built-in-Building)

- Combination of lifting (only up/down) and steel pallet shifting to slide the vehicle to parking place.
- Suitable for small & medium sized above or underground parking lot.
- More parking space in small a piece of land (7.5m x 7.5m)

Parking lot inside view (lift passage) - Standard

Steel Pallet & Traction machine

MACHINE ROOM

3	SEQUENCE OF PARKING

In case site provides some space for entry station in front of auto door (auto door status : closed

- The driver enters the entry station in front of auto door.
- The photo sensor is checking the vehicle height to find whether it is allowable or not.

  (or height bar can be installed as per consultant's recommendation)
- The auto door opens automatically.
- The driver goes forward and stops his vehicle on lift platform.
- The driver leaves lift platform.
- The auto door is closed.
- The driver (or parking lot manager) inputs the vehicle number on touch screen.
- The system starts automatically lifting up to stop a programmed floor.
- The Lift stops on designated empty bay.
- The Pallet is disjoined from lift, then shifts to empty bay, then store vehicle.
- The Lift picks other empty pallet, then relocate to lift platform.

In case site provide only lift platform as entry station(auto door status : opened)

- The driver goes forward and stops his vehicle on lift platform.
- The photo sensor is checking the vehicle height to find whether it is allowable or not.
- The driver leaves lift platform..
- The auto door is closed.
- The driver (or parking lot manager) inputs the vehicle number on touch screen.
- The system starts automatically lifting up to stop a programmed floor.

- The Lift stops on designated empty bay.
- The Pallet is disjoined from lift, then shifts to empty bay, then store vehicle.
- The Lift picks other empty pallet, then relocate to lift platform.

4	SEQUENCE OF EXIT

- The driver (or parking lot manager) calls the vehicle by inputting the number on touch screen
- System automatically retrieves the vehicle as opposite to the procedure of the above "sequence of parking"
- The exit auto door opens, then drive gets in the car
- The driver leaves exit station.

5	PERFORMANCE PARAMETERS

- Targeted storage / retrieval time : within average 2.5 to 3.5min per vehicle
- Sufficient test operation / commissioning before commercial operation post completion
- Training service to local operation team during duration of installation and commissioning; experienced local mechanical and electrical engineers hired by contactor must be dedicated to the Project.
- Contractor has to , provide on-site-operation supporting service till the end of contract period 5 years after commissioning
- The key factors to sustain smooth operation
- Operator (helper) in the entry station to support the process of vehicle entering
- Maintenance service (on-site-supporting / Periodical site investigation twice per month)
- Warranty service for a specific period (2 year defect liability)
- After warranty service, 2years same team shall be continue for another 3 years for operation & maintenance.
- System operation will be very stable as long as consumable parts are replaced on time via periodical maintenance service, so highly recommend to reserve some spare parts including consumable parts for the service.

6	CONTROL PHILOSOPHY

The envisaged system is built around a rugged control system with a latest technology PLC controller along with Supervisory Control and Data Acquisition Package (SCADA) if it is needed. PLC forms the Heart of the System and will be responsible for sequential and orderly operation of the system.

Electrical control system will mainly consists of control cabinet with main switch, fuses, transformer for generating the control voltage, frequency controller, for supply of different three phase current motors, programmable logic control. The power unit shall consist of power fuses; motor protective circuits etc for controlling different drive units. PLC shall have 20% extra capacity for input/ output and for RAM memory. Control panels will be spacious for easy maintenance, proper lighting and with required cooling arrangements. All variable speed motors shall be of AC variable frequency drive with display of speed, current, voltage.

All cables being taken out would pass through grommet to avoid ingress. All wiring would be aesthetically routed through proper channels and secured well wherever possible. All switches and indicator lamps would have legend engraved on black name. All cabling would be routed properly with saddle clamp / trays in aesthetic manner. The panel would have a pocket to contain circuit diagram.

The PLC along would be housed in a centralized control Panel along with all necessary switchgear and safety interlocks. Separate control systems are being provided for the following with individual PLC, Display panel, Communication system, and all other related accessories.

The entire architecture is planned as a Distributed I/O which will reduce the hassles of cabling and in long run maintenance of the project. There will also be a central Master PLC wherein supervisor can visualize the complete material handling operation.

The PLC shall be programmed to function in Auto and Manual modes along with Auto shutdown facility of operation:

Auto Mode of operation:

The Programmable logic Controller shall be programmed to function in the following control philosophy and carry out the process as described under “Operation of the system”.

Operation of the system:

The entire process shall be sequenced as per the process requirement except those mentioned as Manual operation. The Auto operation mainly includes the automatic movement of system as per predetermined sequence depending on the type of operation mode selected. The system loads the entire parameters as per selection of the mode and shall execute the timing cycle in order to ensure good quality of product and optimum cycle time.

Manual Mode:

All the operations in the Manual mode is exactly similar to the operations described in the Auto mode, taking care of all the interlocks and safeties described, except that each movement is advanced by an operator intervention.

This mode is mainly provided for the purpose of Manual override; the process may be operated in manual mode for the desired duration and put back to continuous mode at any stage.

MCC Panel:

Ingress protection class; IEC-529 STANDARD

- Cabinet of main circuit panel : IP 55
- Cabinet of PLC & Inverter : IP 55

The control panel Designed shall provide convenient operational control and are designed for easy installation. The control panel are designed to house motor starter, fused disconnect switch interlocked to the panel door, an amply suited 415/240 volts control circuit transformer, primary overload relays with external reset buttons, integral Start-Stop pushbutton station and sufficient space for additional control Relays.

Proximity Sensors:

- Adequate sensors shall be providing for maximum positions mounted on a clamp, which shall have adequate flexibility for mounting as per system requirement.
- Sensors shall be used at the necessary interlocking of the system.
- Sensors shall be provided at critical positions, to take care of any unforeseen failure.

Photoelectric Sensors: Samples

Panel View HMI system

Software:

A Real time operating system (RTOS) Software for the entire Operation of the system shall be supplied. This includes the controller for all drives, feedback and user interface. Malfunctioning of any sub-system will be detected and alerted to the operator through display and audio alarm.

The Software shall have the following features:
The software developed will be **platform independent** under any standard Operating system.

- The software developed will be real time and the GUI is very user friendly.
- Diagnostic routines with display of all I/O status, user forcible output status, etc., will be considered.
- Data logging routines for operation wise logging of all position data, bundle orientation, etc. will be part of the software.

Safeties:

Report generation routines for data reports will be given.

- Password protection will be given at multi levels for technical staff.
- System can be initiated only when the safe conditions are met with:
- The whole system shall be provided with a fail-Safe, overload protection and the system is halted and Audio-visual alarm provided.
- At strategic locations sensors etc will be provided to have an accident free operation.
- Sequential switching ON and OFF will be planned for the entire process.
- For alarms and default necessary reports will be generated with time stamps.

On failure of process, alarms shall be raised to the operator; system shall be stopped, alarming the operator for necessary intervention.

On taking necessary action of the alarm, the system may be restarted either in auto Mode or switched over to manual mode.

7	SOFTWARE AND ELECTRICAL HARDWARE

a) Software system

- Based on P.L.C, MCU
- Elements
- Parking process including doors operation
- Warning signal lamp
- Monitoring display
- Parking car data & reservation
- Communication system
- Safety control

b) Electrical Hardware system

- PLC : LS XP or Samsung/ Siemens/ Mitsubishi
- Touch screen as operation panel (user's interface)
- Traffic light signal /Terminal block / Circuit brake / NFB (No Fuse Braker)
- Vehicle right position guidance in lift platform (LED displayer)
- Photo Sensor / Power booth bar
- Limit switches / Transformer
- Communication modules
- Magnetic contactors
- Inverters / Encoders or WCS

8	APPLICABLE CODES / APPROVED MAKES

Major Preferred Parts List		
SL.NO.	**PART**	**BRAND /SPEC**
1	Bearings	SKF / FAG/ NTN or Equivalent
2	Type of coupling	Suitable pin type/ fluid coupling
3	Anchor Bolt &Nut H/T Bolt & Nut	SS 316 (M16) or equivalent 10.9 or equivalent UNBRACO/ TVS
4	Chemical Anchor	Hilti RE500 or equivalent
5	Fasteners	HILTI
6	Geared Motor / Drive	
	a) Main Hoisting Motor (induction + reducer)	SEW (Germany)
	b) Mounting/ Type	Foot mounting, Inline helical geared motor
	c) Rating	As per the design calculation
7	Counter weight	4.5-6.5 ton
8	Steel Wire rope	Ex) 8×S19(E)-Ø12 : Usha Martin/ Japanese/ German/ Korean brands
9	Gear coupling	GD 20 or IS 2405 or equivalent
10	Pinion / rack / ring gear	S45C or IS 733 or IS 368 or IS 3688 or IS 7403 or equivalent
11	Universal Joint	Y 120 or equivalent
12	Sheave & Chain	Diamond or equivalent Japanese/ German/ Korean brands
13	Panel Cabinet	(IP-55)
14	PLC & relevant parts	SCADA,HMI Interface , Semmens/ Mitsubishi
15	Inverter	Luminous ,Microteck, Yaskawa (Japan) or equivalent
16	HMI	LS XP series or equivalent
17	Power trolley bar (Compact bar)	Japan/Korea reputed brand/German
18	Sensors / Limit switch	Korea/Japan/Germany brand
19	Cables	Havells, Polycab, LS or equivalent

- All maker, quality control and specification follow minimum Indian/Japanese/European standard or the above standard.
- This list is major part, hence materials can be added or lessened and its specification can be adjusted a little according to determining of project requirements

9	SCOPE OF SUPPLY FOR MATERIALS

	Description of System	Qty
A	**Vertical Transporter (Lift) consisting of :** • Car carrier platform (CAGE) • Turning Device (in case door is shared with entry & exit) • Geared motor • Wire steel rope • Counter weight • Lift rail • Other relevant components	**1 setx3**
B	**Steel Pallet** • Plate to load the vehicle • Pallet wheels (rollers) • Other relevant components	**34x3 sheets**
C	**Steel structure (for metal frame)** • H beam & main steel column • Angles & channels & bracket • Other relevant components	**1 lot x 3**
D	**Auto door system consisting of :** • Sliding or 2-3 up/down (I Set= 2 nos) • Alarm signal lamp • Other relevant components	**1 set x 3**
E	**Electrical system consisting of :** • Main control panel • HMI (i.e Touch screen) • P.L.C. & operation program • Photo Sensors • Cables for Power, Instrumentation, Communication • Other necessary parts and items	**1 lotx3**
F	**Software system** • Based and depend on P.L.C • Parking process including doors operation • Warning signal lamp • Monitoring display • Parking car data & reservation • Communication system • Safety control • Other related program	**1 lotx3**

SECTION-II

SPECIAL CONDITIONS FOR OPERATION AND MAINTENANCE FOR PARKING SYSTEM

1. **Contractor shall provide Minimum Manpower as per the below details for Operation and Maintenance (for 2+3 Years)**

1. 1 Number Electromechanical Graduate Engineer having 5 years of experience/ 1.Nos Electromechanical Diploma Engineer having 10 years of Experience in the same field to Operate and maintain the entire parking system for 24 hours X 365 days. (**Available on call** required for 365 days)

2. 1.Nos Electromechanical Diploma Engineer having 5years of Experience in the same field to Operate and maintain the entire parking system for day time X365 days (**compulsorily** required for 365 days)
3. 2. Numbers ITI Electrician having 5 years of Experience in the same field to operate and maintain the entire parking system. One for day and night shift each. For 365 days) (**compulsorily** required for 365 days)
4. 1. Person having Computer proficiency and graduation is required for the cash Collection having minimum 2, years of Experience as a data entry operator cum cashier. (**compulsorily** required for 365 days)
5. 2. Numbers Security Guard, one for entry and one for exit of the parking building, having minimum qualification as 12th standard graduate, who can also provide guidance to the drivers who are entering /exiting the parking facility (**compulsorily** required for day shift X365 days)
6. 2. Numbers Security Guard, one for entry and one for exit of the parking building, having minimum qualification as 12th standard graduate .who can also provide guidance to the drivers who are entering /exiting the parking facility. (**compulsorily** required for night shift X365 days)
7. Self-attested Credentials and certificates of the manpower to be deployed shall be submitted by the contactor to the engineer In charge before their deployment.
8. Contractor may increase the manpower as per the requirement/situation at the parking facility without charging anything extra to the CLIENT.

Standard maintenance procedure in form of a manual compulsorily be submitted by the contractor with tender document. (**10 marks** to be given towards the submission of maintenance manual for technical qualification)

I. Contractor has to maintain sufficient consumable item inventory within the parking building in advance including all necessary tools and equipment to run the entire parking system uninterrupted 24 hours X365 days for throughout the operation and maintenance period.

II. During the tenure of defect liability period of One years and the operation & maintenance

period after contractor has to indemnify CLIENT from any claims for the losses if any occurred to any person in any form within the parking building or parking facility.

III. **Same field meaning** is a person having experience in operating and maintaining the similar parking facility in India or having experience with lift maintenance company using PLC based operating system /familiar with lesser sensor and its operation .

Third Party Audit/Inspection of parking system

1. Annual Third party Audit /Inspection shall be arranged by the Contractor for the parking Equipment system and the building as well during whole operation and maintenance contract period o
2. Contractor shall submit daily operations log sheet and log book of parking system and the same report generated by the system and submit it to the CLIENT engineer in charge or its authorized representative.
3. Contractor shall submit weekly/monthly/quarterly /half yearly and yearly operational datasheet of every equipment, and Electrical panels / components along with the all sensors of parking system and the same report generated by the system and submit to CLIENT representative.
4. Parking Contractor shall provide required energy for the third party testing, fuels and Lubricants and tools for the checking by third party for free of cost.
5. Third Party Team/Agency shall be Engage by the CLIENT
6. And their testing charges shall be paid by the Contractor during the maintenance contract period. (25000 per visit)

OPERATION MANUAL OF PARKING SYSTEM

1. The Main Contractor shall provide an Operation Manual covering the work of the Civil Contract and all Nominated Sub contracts. Operation Manual shall also be provided by the various equipment suppliers and Nominated Sub-Contractors for integration into the Main Contractor s manual of parking system)

2. The Operation Manual shall be an essential part of the equipment supplied under this Contract. The supply and delivery of equipment will be regarded as incomplete until the draft Operation Manual is submitted and approved. Draft Operation Manual with the content specified shall be submitted in the format specified by CLIENT has developed Operation Manual templates for use by the Main Contractor, Nominated Subcontractors and equipment suppliers of the parking facility.

General:

- A general description of the installation as required for providing a general understanding of the equipment and its operation.
- A technical description of each system of the installation, written to ensure that it can be clearly understood by persons not familiar with the installation.

- Manufacturer's technical literature assembled specifically for the project and excluding irrelevant matter. Each product data sheet marked to clearly identify the specific products and components used in the installation and the data applicable. Additional instructions and illustrations as required to identify any changes to the manufacturer's data or to illustrate the function of each component in the installation.
- The type of equipment.
- A unique identification label attached to each piece of equipment.
- The location of the equipment, including building number and/or name, level number and/or name, room number and/or name and any other information required for prompt and unequivocal identification.
- The type of inspection and maintenance required.
- Space is to be left in order to enable the recording of results of each inspection, with sufficient spare space for not less than two years.
- Space is to be left for comments on each inspection;
- Space for the recording of the date and time of each inspection, the name, title, address and signature of the person performing each inspection.

Maintenance:

- Emergency procedures, including telephone numbers for emergency services, and procedures for fault-finding. Manufacturer's technical literature as appropriate.
- Detailed recommendations for the frequency of performance of routine maintenance tasks.
- List of procedures and tasks associated with preventive (routine) maintenance.
- Procedures for safe trouble shooting, disassembly, repair and reassembly, cleaning, alignment
- Inspection and adjustment, including a logical step-by-step sequence of instructions for each procedure.
- Schedule of spares (including bearings) with an expected operating life less than 4,000 hours, including item label manufacturer Details (name, address and telephone number) and catalogue number or local distributor details (name and address) , and the expected replacement frequency.
- Schedule of consumable items (oil, grease, belts, bearings) to be used during servicing
- A schedule of the frequency of the required or recommended maintenance, testing or inspection for each type of equipment. This schedule is to include weekly, monthly Cycle of maintenance times.
- A separate schedule for each type of equipment, other than Essential Safety Provision.
- List of tools and testing equipment required along with Instructions for the use of tools and testing equipment.

Operation:

- Manufacturer's technical literature as appropriate. For other than common accessories, where no manufacturer literature is available, a precise and concise description of the operation procedure in plain English.
- Safe starting, running, operating and shutting-down procedures for the equipment installed including a logical step-by step sequence of instructions for each procedure.

- Control sequences and flow diagrams for the systems installed.
- A legend for color-coded services. A legend of the symbols used on the drawings, unless included on the drawings.
- Schedules of the parameter settings of each protective device, including fixed and adjustable circuit breakers, protective relays, adjustable photoelectric switches, pressure switches, and any other control and monitoring device, as established during commissioning and maintenance.
- Outline of any provisions made for essential services, as per equipment and its components specific to the project.

SPECIAL CONDITIONS

- Copies of manufacturers warranties.
- All guarantees
- Certificates from authorities.
- Certificates of compliance for all electrical and plumbing works (to be included within the respective maintenance manuals). Where, in agreement with the Project Manager, no manuals will be submitted, these certificates will be presented to the Project in charge (consultant) for inclusion in the Contractor's Manual.
- If installation is not by the manufacturer, and product warranty is conditional on the manufacturer's approval of the installer, submit the manufacturer's approval of the installing firm.
- Records of test results.
- Records of commissioning data.

Submission of Draft Copy of Manuals

1. Within 21 days prior to the commencement of commissioning of the Works the Contractor shall provide to the Consultant/Engineer in charge for approval, one (1) digital copy of the draft Operation Manual for all items, or groups of similar items of equipment supplied under the Contract.

2. The manual shall be specific to equipment being supplied. Supplier equipment manuals, Catalogues, sales brochures and other documents giving general information will not be acceptable alone as Operation Manual.

3. The Operation Manual shall be formulated according to the requirements of CLIENT Operation Manual Writing Guide. The scope of the process element operation instructions to be created or amended by the Contractor shall be agreed to by the SDMS prior to preparation of the process element operation instructions.

Submission of Digital Version Manuals

4. Prior to the commencement of commissioning of Works, the Contractor shall provide to the Consultant/Engineer In charge compact disc containing the digital

Operation Manual f o r approval. This shall include all electrical, mechanical, Parking Equipment and instrumentation equipment provided by it or its sub-contractors.

5. The digital Operation Manual shall be formulated according to the requirements of CLIENT Operation Manual Writing Guide.

Format of Hard Copy Manuals

6. Text shall be submitted on A4 sheets, with a minimum weight of 90 GSM. Drawing sizes are to be confined to maximum of A3 size (90 GSM) and folded to A4 size in such a way that their title block is visible. Prints of drawings shall be made using a black and white printing process, and shall be sufficiently clear to allow reproduction without loss of legibility by a digital scanning system.

7. The Operation Manual is to be supplied in a white 4 ring A4 binder.

Submission of Routine Maintenance manuals

Contractor shall submit to consultant/Engineer in charge ,The manual shall be sufficiently comprehensive for routine maintenance, overhaul and repairs to be carried out by personnel who are qualified to undertake maintenance work but who are not necessarily familiar with the equipment. The manual shall contain the following information:

a) <u>A comprehensive list of contents including:</u>

a. Equipment Name (and number if applicable).

b. Equipment Type and Model Number.

c. Equipment Capacity description.

d. Manufacturer's Name.

e. Equipment Supplier's Name, Address and Telephone Number.

f. Service Representative's Name, Address and Telephone Number.

b) <u>Data sheets for each equipment item (including individual components) shall provide:</u>

1. Title (i.e. "Data Sheet").
2. Equipment Name (and number if applicable).
3. Equipment Type, Model Number, Serial Number.
4. Specific Design Characteristics.
5. Performance Characteristics (including any relevant curves).
6. Lubrication Type including: specification, brand and quality etc.
7. List of individual items of equipment which are components of, or are associated with, the equipment described in this sub-clause of the Specification.
8. Reference Drawing List.
9. All other information necessary to fully specify the item of equipment.
10. Equipment supplier's name, address and telephone number.

c) Operating instructions and description of the equipment and its principles of operation including:

1. Theory of Operation.
2. Function of Equipment.
3. Pre-Start-Up Checks and Adjustments.
4. Start-Up Procedures.
5. Normal Operating Modes (for each component of Parking system)
6. Normal Shut-Down Procedures.
7. Process Controls.
8. Visual checks and observations that should be made routinely to ensure equipment is operating satisfactorily.
9. Diagnostic troubleshooting techniques, where applicable, to determine probable causes of operating difficulties or alarm situations.

d) Maintenance instructions in tables provided in template showing:

1. Recommended preventative maintenance procedures, tests and activities to ensure that equipment and components are adequately maintained by the parking contractor..
2. Frequency that each preventative maintenance procedure should be carried out.
3. Lubrication points and recommended lubricants.
4. Details of any special tools, lubricants or cleaning agents necessary to implement the preventative maintenance procedures.
5. Spare parts lists with cross reference to sectional drawing shall include:
   i. Part Name.
   ii. Part Number (identification for ordering of spares).
   iii. Number of parts required.
   iv. Material of Construction.
   v. Availability.
   vi. Supplier.

Function, application, specification, and comprehensive technical data of all equipment including sub-assemblies, proprietary items, and system circuit and schematic diagrams thereof where applicable.

1. Troubleshooting.
2. Lists of spare parts recommended to be held in stock.
3. Procedure of ordering spare parts.
4. The manual shall contain clear and comprehensive illustrations and/or drawings with all parts readily identifiable.
5. The Contractor may provide this information for review and comment by the Consultant/Engineer in charge prior to the final submission.
6. After the completion of Commissioning, the Contractor shall supply one (1) fully indexed Hard Copy of the Operation Manual and one (1) digital copy on compact disk to the Consultant/Engineer in charge, including any amendments to the information previously supplied which may have become necessary in light of the commissioning process.

7. The Contractor shall not be entitled to a Certificate of Practical Completion until all required Process Elements of the Operation Manual have been submitted to, and accepted by, the consultant/Engineer in charge
8. The Contractor shall weekly submit the revenue generated from facility as requested (in written) by employer.

FORMULAE FOR O&M PER YEAR

- The Quoted Sum (lump sum) for Operation and Maintenance Amount shall be paid to the contractor (conditional to his fulfilling of conditions and terms of the contract as per the desired specifications) annually.
- The cost of operation and manpower deployment (apart from maintaince cost) during the first year of O&M period shall be payable as a fraction along the four part payments in the consecutive years of the contract and is not to be considered separately.
- A part amount shall be paid at the end of each year of O&M, their sum totaling to the amount quoted in Lump sum. The following describes the calculation of amount of such 'PART AMOUNT(s)' to be paid each year:

TOTAL COST of O&M =TC

Here, TC is given as, TC= [nX+Y (M)]

Where,

"**M**" is the factor of multiplication based on the cumulative sum of the present value of equal annuity paid for 4 years at an annual discount rate of 5%

X is the amount to be paid to contractor at the base year (year 1 after completion of year 1 of O&M)

R is the interest rate at 5% (to compensate yearly increase of operation and maintenance cost due to wearing of equipment)

Y is the amount added annually to principal amount with add-on interest and is calculated as;

(Interest factor at year)**Yn**= [(n-1) X] R [n is the nth year, i.e. from year 2 to end of year 5 of O&M period]

[R is the discount rate]

At every year therefore, the amount payable annually can be calculated as:

Amt. (**An**) = X + Yn

= **X + [(n-1) X] R**

So, net payable amount is calculated as;

Total amount (**T.C.**) = $A_1 + A_2 + A_3$

= X + [X+0.05X] + [X + 0.1025X] + [X + 0.107625X]

= 3X + 0.260X

= 3.26X

T.C. = 3.26 X

Therefore, X (amount for base year 1) = **T.C/ 3.26**

And also, n=3, M=3.26