A. CIVIL work

Mode of Measurements

1.0 EXCAVATION:

1.1.1 Footings: Area of excavation for footing shall be measured equal to area of lowest concrete course as shown on drawing. Depth shall be measured vertically from ground level to bottom of concrete course or dry rubble packing as the case may be.

1.1.2 Plinth beams: Depth of excavation for plinth beam shall be measured from ground level up to bottom of beam and width equal to width of beam.

1.1.3 Where excavation is made, in trenches, measurements for cutting depth shall be taken by means of tape and staff and the width of lowest concrete or rubble packing shall be considered as the width of excavation. When excavation is made for leveling the site, levels shall be taken before start and after completion of work and the total quantity of excavation in cutting computed from these levels.

1.1.4 Where soil including decomposed or soft rock and hard rock are mixed, hard rock after excavation shall be stacked separately. Measurements of the entire excavation shall be taken as indicated above. Excavation of hard rock shall be measured from stacks of excavated hard rock and reduced by 50% to allow for bulkage and voids. The quantity so arrived at, shall be paid under hard rock. The difference between the quantity of entire excavation and quantity payable for hard rock shall be paid as soil. (including decomposed or soft rock)

1.1.5 Width of excavation shall be considered as per BOQ Specific Items and as per preamble.

1.1.6 The unit of measure in all the above cases shall be in cubic meters or as specified in the Bill of Quantities.

1.2. EARTH FILLING:

Measurement for filling when it has been stipulated to be separately paid for, shall be, unless otherwise specified, as follows:-

1.2.1 In open spaces: Filling shall be measured from cross sections of embankments, before start of work and after completion of work by means of level taken at suitable places. When it is not possible to measure filling from cross section, it may be measured in loose stacks or lorry measurements with previous written permission of Clerk-of-Works and 20% deduction shall be made from measured quantity to arrive at payable quantity.

1.2.2 In plinth: Consolidated filling shall be measured without any deduction of voids.

The unit of measure in above cases shall be in cubic meters or as specified in the Bill of Quantities.

1.3. BRICK MASONRY:

1.3.1 Walls exceeding 150 mm brick/ thick shall be measured in unit of one cubic meter. Deductions for all openings, lintels, recesses shall be made except for the following:

i) When openings are less than 45 cm in both the directions or less than 45 cm dia on the surfaces.

ii) When beams & wall plates do not have bearing over entire thickness of wall.

iii) No extra will be paid for providing such openings, recesses etc..

1.3.2 Half brick walls : Net area over one surface shall be measured. Deductions for all openings, lintels, recesses shall be made as in 1.3.1.

1.4. CEMENT CONCRETE (Plain and Reinforced) :

1.4.1 Cement concrete items shall be measured exclusive of the steel reinforcement and plaster thickness but shall include necessary cost of shuttering, scaffolding, supporting, hacking, centering and curing. Items like R.C.C. precast jalis, R. C. pipes and other such articles which are normally manufactured in factories as well as those items which have been so specifically mentioned in schedule of quantities shall be measured inclusive of reinforcement. No deductions will be made when openings are less than 45 cm in both directions or 45 cm in diameter and no extra will be paid for providing such openings.

1.4.2 Foundation concrete: Will be measured in the unit of one cubic meter and to exact dimensions as shown on drawing or as actually laid as per instructions.

1.4.3 Footings, columns, beams, lintels, sills and bed blocks: Shall be measured in cubic meters. Portions of beams and columns embedded in slab shall be paid at the rate of slab. Only projecting rib of beam shall be paid for at the rate of beam. In case of junctions of columns and beams and/or lintels, columns shall be measured between slabs. In case of junction of columns and footings, the footing will be measured in full and the column above the footing.

1.4.4 Slabs and Chajjas : Shall be measured in cubic meters. Slab shall be measured full throughout. Where slabs of different thickness meet, the highest thickness will be taken into account. For chajja only projected portion shall be measured.

1.4.5 Parapet wall, apron wall and drop wall from chajja having drop exceeding 5 cm. Actual cubic contents for portion projecting over slab or beam shall be measured. If drop from chajja is 5 cm or less, the same shall be measured under chajja item.

1.4.6 Projected bands: Projection of 15 cm or less in breadth and thickness shall only be considered as band. The band shall be measured in cubic meters. Deductions will not be made on account of grooves, patties, bands, molds etc. nor will any extra be paid for forming such grooves or features.

1.4.7 Staircase: Measurements shall be per cubic meter comprising of step and soffit slab. All landings, and landing beams shall be paid separately under slab and beam measurements. In the case of soffit slab resting on beams, the portion of beam projecting below landing slab shall be measured and paid as beam. Side parapet walls, railings, finishing of risers and treads and plastering etc. shall be paid separately.

1.4.8 Reinforcement: Shall be measured on standard weight basis for the length and size of bars as shown in drawing. Wastage, rolling margin, spacers, chairs etc. required for construction purpose, and binding wire will not be measured. Lapping of bars shall be provided only as per instructions of the RCC Consultant, and the same shall be paid for. The rate will be inclusive of labour involved in cleaning, cutting, bending & erecting.

The rate will be inclusive of labour involved in cleaning, cutting, bending and erecting in position. The unit of measure shall be in metric tons.

1.5. STRUCTURAL STEEL WORK:

1.5.1 Weight of bolts, nuts, rivets, washers etc. used will not be considered for payment. Only the weight of the main members calculated on length basis at standard weight will be paid to nearest cm. No deduction shall be made for holes, bolts or rivets and wastage involved in cutting, for notching ends of sections or intermediate points for making connections. No additional payment shall be made for welding, riveting and bolting. The units of measure shall be in Kg. or MT as per Schedule of Quantities. Gusset plates shall be actually weighed and paid accordingly.

1.6. DOORS, WINDOWS, ROLLING SHUTTERS AND GATES:

1.6.1 These shall be measured in the unit of Square Meters.

i) Teak wood doors, windows and ventilators: Clear area over one face inclusive of frame shall be measured. Hold fasts and portions embedded in masonry or flooring shall not be measured.

ii) Steel doors, windows and louvers: Clear area over one face inclusive of frame shall be measured. Hold fasts or portions embedded in masonry or flooring shall not be measured.

iii) Steel rolling shutters and rolling grills; Dimensions shall be the clear width between side jambs and clear height between floor and bottom of lintel or beam. Cover will not be measured separately.

1.7. FLOORING, SKIRTING AND DADO:

The net area covered shall be measured in sq. mts.

1.8 PLASTER:

Net area of surface plastered shall be measured in Sq. Mts. No deduction will be made for openings each less than half Sq.Mt. in area. No extras will be payable for any grooves, patties, bands, molds, (including drip molds) which are deemed to be included in the internal and external plastering items.

1.9. PAINTING AND COLOUR OR LIME WASH:

NOTE : All wood work and steel items given in Schedule of Quantities are generally inclusive of painting, but if these are required to be measured separately, then the following procedure shall be adopted.

1.9.1 Net area of surface painted shall be measured in sq.mts. No deductions shall be made for unpainted surfaces or openings less than half sq.mts. each. The rates shall be inclusive of cleaning glasses and fittings.

a) Walls : Net area of surface painted shall be measured. Extra for moldings, recesses and the like shall not be paid.

b) WOOD WORK:

Description	**How measured**	**Multiplying factor**
i) Paneled framed ledged braced and	Measured flat (not girthed) including frame; edges; chocks cleats etc shall be deemed to	1.30 (for each side)

battened	be included in the item	
ii) Flush	Measured flat (not girthed) including frame edges; chocks cleats etc shall be deemed to be included the item.	1.20 (for each side
iii) Partly paneled & partly glazed / glazed	------ As above ------	1 (for each side)
iv) Fully glazed or partly glazed	------ As above ------	0.80 (for each side)
v) Guard bars balustrades gratings and railings	Measured flat over all, no deduction shall be made for opening. (Supporting members shall not be measured separately)	1 (for painting all over)

c) METAL WORK:

Description	**How measured**	**Multiplying factor**
i) Fully glazed or gauzed doors and windows / partitions	Measured flat over) frame. No deduction shall be made for openings. In case of gates supporting members like stays, guide rails, hinges shall not be measured	0.50 (for each side)
ii) Rolling Shutters	Measured flat (size of opening) overall; jamb guides, bottom rails and locking arrangements etc. shall be included in the item (top cover shall be measured separately)	1.10 (for each side)
iii) Collapsible gate	Measured flat (size of opening)	1.50 (for painting overall)
iv) R.C.C jali and Fencing	Measured flat overall No deductions shall be made for openings	1 (for each side)

MATERIALS MINIMUM SPECIFICATIONS/ REQUIREMENTS

1) Material shall be of best approved quality obtaining and they shall comply with the respective Indian Standard Specification.

2) Samples of all materials shall be got approved before placing order and the approved sample shall be deposited with the Architect.

3) In case of non-availability of materials in metric sizes the nearest size in FPS units shall be provided with prior approval of the Architects for which neither extra will be paid nor
shall any rebates be recovered.

4) If directed, materials shall be tested in any approved Testing Laboratory and the test certificates in original shall be testing including charges for repeated tests, if ordered, shall be borne by the Contractor.

5) It shall be obligatory for the Contractor to furnish certificate, if deemed by the Architects, from manufacturer or the material supplier that the work has been carried out by using their material and as per their recommendations.

6) All materials supplied by the Employer / any other Specialist Firms shall be properly stored and the Contractor shall be responsible for its safe custody until they are required on the works and till the completion of the work.

7) Unless otherwise shown on the Drawings or mentioned in the “Schedule of Quantities” or special specification, the quality of materials, workmanship, dimensions, etc., shall be as specified as hereunder.

8) All equipment and facilities for carrying out field tests on materials shall be provided by the Contractor without any extra cost.

a) **Cement:**
Cement shall comply in every respect with the requirements of the latest publications of IS: 269 and unless otherwise specified ordinary Portland Cement shall be used.

The weight of ordinary Portland Cement shall be taken as 1440 kg. per cu.m. (90 lbs.per c.ft.). Cement shall be measured by weight and in whole bags, and each undisturbed and sealed 50 kg. bag being considered equivalent to 35 liters (1.2 c.ft.) in volume care should be taken to see that each bag contains full quantity of cement. When part bag is required cement shall be taken by weight or measured in measuring boxes.

No other make of cement but that approved by the Architects will be allowed on works and the source of supply will not be changed without approval of Architect in writing. Test certificates to show that cement is fully complying the specifications shall be submitted to the Architects and notwithstanding this, the Architect may at his discretion, order that the cement brought on site and which he may consider damaged or of doubtful quality for any reason whatsoever, shall be re-tested in an approved testing laboratory and fresh certificates of its soundness shall be produced.

Cement ordered for re-testing shall not be used for any work pending results of re-test.

Cement shall be stored in weather-proof shed with raised wooden plank flooring to prevent deterioration by dampness or intrusion of foreign matter. It shall be stored in such a way as to allow the removal and use of cement in chronological order of receipt i.e., first received being used first used. Cement deteriorated and or clotted shall not be used on the work but shall be removed at once from the site. However, allowing use of warehouse set cement shall be determined by the Architect.

b) **Lime:** Lime shall comply in every respect with the requirements of IS: 712 and shall be made from approved line stone or kankar and properly burnt. It shall be free from excess of unburnt kankars or lime stone ashes or other extraneous materials and shall be stored in weather-proof sheds. Lime which has damaged by rain, moisture, or air slacking shall not be used but shall be removed from the site of work forthwith. Lime

shall be slacked with fresh water and screened through appropriate screens and stored and used within 14 days provided it is protected from drying out.

Field tests according to IS: 1624 shall be carried out from time to time to determine the quality of lime.

c) **River Sand:**
River sand shall confirm to IS: 383 and relevant portion of IS: 515. It shall pass through pass through a I.S. sieve 4.75 mm. (3/16 B.S.) test sieve, leaving a residue not more than 5%. It shall be from natural source i.e. only river or crushed stone screenings, if allowed, chemically clean, sharp, hard
durable, well graded and free from dust, pebbles, clay, shale, salt, organic matter, loam, mica or other deleterious matter. The sum percentages of all deleterious substances to acceptable limits. River sand shall not contain any trace of salt and it shall be tested and river sand containing any trace of salt shall be rejected.

The fine aggregate i.e. river sand for concrete shall be graded within limits as specified in IS: 383 and the fineness Modules may range between 2.60 to 3.20.

The fine aggregate shall be stacked carefully on a clean hard dry surface so that it will not get mixed up with deleterious foreign materials. If such a surface is not available a platform of planks or corrugated iron sheets or brick floor or a thin layer of lean concrete shall be prepared.

d) **Fine & Coarse Aggregate:**
Shall consist of crushed or broken stone 95% of which shall be retained on 4.75 mm. IS tests sieve. It shall be obtained on crushing Granite, Quartzite, Trap, Basalt, or similar approved stones from approved quarry and shall confirm to IS:383 and IS 515. Fine & Coarse aggregate shall be chemically inert when mixed with cement and shall be cubical in shape and be free soft, friable, thin, porous, laminated or flaky pieces. It shall be free from dust and any other foreign matter.

Gravel / Shingle of desired grading may be permitted as a substitute in part or full in plain cement concrete if the Architect is otherwise satisfied about the quality of aggregate. For all the R.C.C. works the size of coarse aggregate shall be 20 to 25 mm. and fine aggregate shall be 10 to 15 mm.

e) Rust Free Reinforcement :
Reinforcement shall be of mild steel tested quality confirming to I.S.: 432-1966 and any other I.S. applicable or deformed bar confirming to IS:1786 and Is:1139 or hard drawn Fe 415 /500/550 (Tor Steel) steel wire fabric confirming to IS:1566;1967.

All finished bars shall be free from cracks, surface flaws, laminations, jagged and imperfect edges.

f) **Bricks:**
Bricks shall generally comply with IS:1077 except in size which shall be classified as 1st and 2nd class.1st class bricks shall be the best quality locally available table moulded, well burnt but not over burnt, have plain rectangular faces with parallel sides and sharp right-angled edges, have a find compact and uniform texture. The bricks shall be free from cracks, chips, flaws, stones or subsequent to soaking in water. It shall emit a clear ringing sound on being struck and shall not absorb water more than 20% by weight. Common building bricks shall have a compressive strength of 35 kg. / sqm unless otherwise specified for first class bricks.

g) **Neeru:**
Shall be made of Class “C” Lime (i.e. pre-fat lime) as mentioned in IS: 712. It shall be slaked with fresh water then sifted and reduced to a thick paste by grinding in a mill. Neeru thus prepared shall be kept moist until used and no more than that can be consumed in 15 days shall be prepared at time.

h) **Surkhi :**

Shall be made by grinding well burnt bricks, brick bats, burnt clay balls, etc., the brick etc., to be used shall be prepared from selected clay. The quality shall confirm to IS:1344.

Bricks bats, etc., shall be ground in mechanical disintegrator to a find powder passing through IS Sieve No. 9 (2.36 mm.) with a residue not exceeding 10% by weight.

Surkhi for lime surkhi plaster shall be ground to fine powder in a mortar mill to pass through IS Sieve 150 micron (No. 100).

Surkhi shall be stored in a weather-proof shed on a brick pave platform.

i) **Water:**
Water for mixing cement / lime / surkhi mortar or concrete shall not be salty or brackish and shall be clean, reasonably clear and free from objectionable quantities of silt and traces of oil, acid and injurious alkali, salts, organic matter and other deleterious materials which will either weaken the mortar or concrete or cause affluence or attack the steel in reinforced cement concrete. Water shall be obtained from sources approved by the Architect. Potable water is generally considered satisfactory for mixing and curing concrete, mortar masonry, etc., where water other than main source is used this shall be tested in an approved testing laboratory to establish its suitability. All charges connected therewith shall be borne by the Contractor.

j) **Timber:**
Timber shall be well seasoned and of the best quality Indian Teak of specified species viz., Dandeli, Balarshah, Melabar, C.P.

Timber shall be considered as well seasoned, if its moistures content does not exceed the following limits.

a) Timber for frames 14%
b) Timber for planking, shutters, etc. 12%

The moisture content of timber shall be determined according to method described in paragraphs 4 of IS:287 for Maximum permissible moisture content of timber used for different purpose in different climatic zones.

In measuring cross-sectional dimensions of the frame pieces tolerance up to 1.5 mm. shall be allowed for each planed surface.

k) **Superior quality Indian Teak Wood:**
Superior quality Indian Teakwood means Dandeli, Balarshah, and Malabar Teak. It shall be of good quality and well-seasoned. It shall have uniform colour, reasonably straight grains, and shall be free from large. Loose, dead knots, cracks, shakes, warp, twists, bends, borer holes, sapwood or defects of any kind. No individual hard and should knot shall be more than 1 cm. in diameter and aggregate areas of all knots shall not exceed ½% of area of the piece. There shall not be less than 6 growth rings per 2.5 cm. width.

l) **1st Class Indian Teakwood:**
1st Class Indian Teakwood means C.P. and Bulsar teak of good quality and well-seasoned. It shall have uniform colour, reasonably straight grains and shall be free from large. Loose dead knots, cracks, shakes, warp, twists, bends, sapwood or defects of any kind. No individual hard and should knot shall be more than 2.5 cm. in diameter and aggregate areas of all the knots exceed 1% areas of the piece. There shall not be less than 5 growth tings per 2.5 cm. width.

m) **2nd Class Indian Teakwood:**
Shall be similar to first class Indian teak wood except that knot up to 4 cm. diameter and aggregate area of all knots up to 1 ½% of the area of the piece shall be allowed. There shall not be sapwood up to 15% is allowed.

n) **Flush Doors:**
All flush doors shall be solid core exterior grade unless otherwise specified and it shall

generally confirm to IS:2202 and shall be fabricated as described under specification.

o) **Steel Windows and Doors:**
Steel windows and doors shall be fabricated of steel sections conforming to IS:226. They shall conform to IS 1038. Unless otherwise specified the details of construction etc., shall be as described under specification.

p) **Floor Tiles:**
Designer pre-cast concrete tiles and interlocking paver block, plain cement tiles, chequred tiles, mosaic tiles terrazzo tile shall conform to IS:1237. For neutral shade tiles grey cement shall be used. Tiles shall be compacted by mechanical vibration and hydraulically pressed. It shall be of choice shade and shall have desired pattern of chip distribution. The sizes of chips to cement in terrazzo or mosaic floor shall be as specified in IS:1237. The size and thickness of tiles shall be as approved by the Architect.

q) **Ceramic / Vitrified Tiles:**
White or coloured glazed tiles shall comply with IS:777 or relevant or latest I.S. code. It shall be from an approved manufacturer and shall be flat and true to shape. They shall be free cracks, crazing, spots, chipped edges and corners. The glazing and colour shall be uniform shade and unless otherwise specified the tiles shall be 6 mm. thick.

r) **Marbles:**
Marble slabs for flooring, dado veneering etc., shall be of kind specified in the item such as white or pink, Makrana, Chittor black, Bhanslana black, Jaisalmer yellow, Baroda green, Patiala (Pepsu) grey, etc., Marble from which slabs are made shall be selected quality, hard, sound dense and homogenous in texture and free from cracks, weathering, decay and flaws. Before starting the work, the contractor shall get the sample of Marble slabs approved by the Architect. The slabs shall be machine cut and machine polished.

s) **Kotah / Shahbad / Cudappa / Granite:**
Shall be of selected quality, hard, sound, dense, and of homogeneous texture, free from cracks decay, weathering and flaws. Stone slabs shall be of uniform colour as approved by the Architect. They shall be machine cut and machine polished where specified and shall confirm to the required size. Thickness shall be specified in the respective items.

t) **Glazing:**
Glass used for glazing shall be float glass of best quality, free from flaws, specks bubbles and shall be 2.9 mm. thick up to 0.60 x 0.60 mm. size and for larger size it shall be minimum 4 mm. thick unless otherwise specified in the Schedule of Quantities.

The following type of glasses shall be used: -

1) For Office Building Clear glass or as specified in the Schedule of Quantities.
2) Office (toilets) Clear or frosted
3) Partitions Frosted

u) **Asbestos Roofing & rain Water Pipes:**
All Asbestos pipes and fittings shall comply with IS:459 and shall be free from cracks, chipped edges of corners and other damages.

v) **MPI. Sheets:**
MPI. Sheets shall be of a gauge specified in the description of the item and shall conform to the IS:277. The sheets shall be free from cracks, spilt edges, twists, surface flaws, etc. They shall be clean bright and smooth. Galvanising shall be uninjured and the perfect condition. The sheet shall show no sign of rust or white powdery deposits on the surface. The corrugations shall be uniform in depth and pitch and parallel.

w) **Paints:**
Lime for lime wash, dry distemper, oil bound distemper cement primer, oil paint, enamel paint, flat oil paint, plastic emulsion paint, anti-corrosive primer, red lead, water-proof cement paint and exterior grade Acrylic Emulsion paint, cement paint, sand-tex matt shall be from an approved manufacturer and shall conform to the latest Indian Standard for various paints and shall be as per Green Building Norms **with low VOC content** withing prescribed limits. Ready mixed paints as received from the manufacturer without any admixture shall be used, except for addition of thinner, if recommended by the

manufacturer.

x) **Mortar:**

1) Lime Surkhi Mortar : Lime and surkhi shall confirm to the specifications. It shall be composed of approved lime and surkhi in proportion of 1 lime to 2 surkhi mixed thoroughly. The ingredients shall be accurately gauged by measure and shall be well and evenly mixed together on a platform and water added to make it homogeneous. When large quantities are required, the mortar shall be mixed in a mechanical grinder.

2) Cement Mortar: Cement mortar shall be of proportions specified for each type of work in the schedule. It shall be composed of Portland Cement and sand. The ingredients shall be accurately gauged by measure and shall well and evenly mixed together in a mechanical pan mixer, care being taken not to add more water than is required. No mortar that has begun to set shall be used. River sand shall be used unless otherwise specified.

If hand mixing is allowed, then it shall be done on pucca water-proof platform. The gauged materials shall be put on the platform and mixed dry. Water will then be added and the whole mixed again until it is homogenous and of uniform colour. Not more than one bag of cement shall be mixed at one time and which can be consumed within half an hour of its mixing.

3) Composite Lime, Cement, Sand Mortar: The mortar shall be of proportions specified for each type of work in the schedule of quantities. It shall comprise of Portland cement, lime and sand. Lime shall be measured in gauge boxes similar to one used for measuring cement and sand to the proportion specified and sufficient water then added to it to form a thick slurry thus obtained shall then be added to dry cement and sand mixture and thoroughly mixed to make a workable homogenous mortar of uniform colour by adding more water if necessary. Mechanical mixers shall generally be used for mixing such mortars. If hand mixing is allowed it shall be done on pucca platform.

xi) AAC Blocks:

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

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

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

The drying shrinkage shall be not more than 095 percent for Grade 1 blocks and @ 10 percent for Grade 2 blocks when tested as per table no 9.4 of IS 2185 -3(1984).

xii) Windows

The cross section of the profile must confirm to the shape and dimensions of the manufacturer’s specification and drawing maximum tolerance on outer surface shall not be more than ±0.5 mm and glazing and seal grooves shall not deviate more than ±0.3 mm.

The straightness of the profile as measured on the surface shall not deviate by more than 1.0 mm/meter.

The weight of the profile section per meter shall not be less than 3% of normal value.

XII) RMC GUIDELINES

1.0 GENERAL REQUIREMENTS OF RMC

1.1 Basis of Supply: All concrete shall be supplied and invoiced in terms of cubic meters (full or part) of compacted fresh concrete as discharged from the transportation unit. The RMC shall be supplied in the quantity and having the quality in accordance with the requirements agreed by the producer or supplier and purchaser or user; however, the concrete supplied shall generally comply with the requirements of IS 456/ IS 457 and IS 4926. The volume of fresh concrete in a given batch shall be determined from the total mass of the batch divided by the density of the concrete. The total mass of the batch shall be determined as the mass of the concrete in the batch including the total mixing water. All Batching shall be carried out by mass, except water and admixture, which may be measured by volume.

1.2 Specifying Concrete – Ordering RMC shall be manufactured and supplied on either of the following basis.

a) Performance basis: Specified characteristic strength based on 28 days (or any other specific age) compressive strength in accordance with IS 456/ IS 457.

b) Prescriptive basis: Specified Mix Proportion. When concrete is supplied on the basis of specified strength, responsibility for proportioning of mix rests with the producer/ seller whereas in case of specified mix proportion, the responsibility for proportioning of mix rest with the purchaser and the purchaser accepts the responsibility for concrete strength and its performance. Thus, it is desirable to place the **supply order on specified strength basis.** This system is based on performance parameters and is best way to order the RMC because RMC producer, who is expert in the field would design an economical mix with desired properties. In all cases the purchaser/user is required to furnish the following information for the guidance of the producer/ seller.

a) Type of cement to be used.

b) The max. Size and type of aggregates to be used.

c) The workability specified by slump or any other requirements.

d) Following additional requirements should be specified to satisfy durability requirements:

i) Minimum and maximum cement content to be used in production of concrete.

ii) Maximum water cement ratio to be kept.

iii) Total chloride content in concrete: - Total chloride content should not exceed 0.15% by mass of cement in case of RCC work (IS:456) . For prestressed concrete work, total chloride content should not exceed 0.06% by mass of cement. (IS: 1343)

iv) Total sulphate content: - It should not exceed by 4% by mass of cement.

v) Permeability test requirements. (if any)

vi) Any special requirements such as pumpability or self-compacting concrete (SCC) etc.

1.3 Mixing of Concrete Ready-mix concrete is mixed and delivered to the point/site designated by the purchaser/user by means of one of the following combinations of operations.

a) Central Mixed or Stationary mixed Concrete: Concrete that is mixed in a stationary mixer at plant that mixes the concrete completely before it is discharge into either in a truck agitator or truck mixer operating at agitating speed or in non-agitating equipment as agreed to by the purchaser/user. Central mix plants are sometimes referred to as wet batch or pre mix plants. When a truck mixer or agitator is used for transporting concrete which has been mixed before leaving the plant, the concrete shall agitated during transit and re-mixed at the site for at least 2 minutes so that the concrete is of the required uniformity.

b) Shrink Mixed Concrete: Concrete that is first partially mixed in a stationary mixer and then mixed completely in a truck mixer. The time of partial mixing shall be minimum required to intermingle the ingredients. After transfer to the truck the amount of mixing at the designated mixing speed will be that necessary to meet the requirements for uniformity of concrete. Generally, it is two minutes of mixing in truck drum at mixing speed. This is not being practiced.

c) Truck mixed concrete: Although, truck mixed concrete is also one of the methods of mixing of Ready Mixed Concrete, for the purpose of this chapter, truck mixed concrete shall not be allowed as RMC, as automatic record keeping arrangement such as digital computer slips etc. are not possible in such type of mixing. Regarding mixing whether in a stationary or central mixer it shall be ensured that it complies with performance criteria of mixing efficiency test as per IS 4634:1991. Mixing efficiency test shall be performed at least once in a year.

1.4 Information to be supplied by the purchaser/user of RMC plant The purchaser shall provide the details of the concrete mix or mixes required by him and all pertinent

information on the use of the concrete and the specified requirements. Where the purchaser specifies a designed mix to be supplied it is essential that all relevant information is conveyed to the producer. In order to assist in this, the format given in IS 4926 Annex D may be completed and forwarded to the producer at the time of enquiry. The concrete mix shall be specified by its constituent materials and the properties or quantities of those constituent to produce a concrete with the required performance. The assessment of the mix proportions shall form an essential part of the compliance requirements. The purchaser shall provide the producer with all pertinent information on the use of the concrete and the specified requirements. In order to assist in this, the format given in IS 4926 Annex D may be followed with suitable modifications as applicable to prescribed mixes. Purchaser responsibilities: The purchaser of Ready-mix concrete has the following responsibilities

i When placing procedures can potentially alter the characteristics of fresh concrete, it is the responsibility of the purchaser to inform the producer of changes to the mixture requirements to accommodate these effects. An example is pumping concrete in place.

ii When a job uses more than one type of concrete mixture, it is the purchaser's responsibility to verify the mixture delivered and direct it to the correct placement location.

iii The purchaser should check and sign the delivery ticket and document any special occurrences on the ticket.

iv When strength tests are used for acceptance of concrete, the samples should be obtained at the point of discharge from the transportation unit.

v The purchaser or his representative should ensure that proper facilities are available for curing the test specimens at the jobsite and that standard practices are followed for subsequent curing and testing. Certified personnel should conduct the tests.

vi Test reports should be forwarded to the producer in a timely manner to ensure that deficiencies are rectified.

1.5 Information to be supplied by the producer/owner of RMC plant Upon the request, the producer shall provide the purchaser with the following information before any concrete is supplied:

a) Nature and source of each constituent material.

b) Source of supply of cement, and

c) Proposed proportions or quantity of each constituent/m3 of fresh concrete. d) When requested, the producer shall provide the purchaser the following information of admixtures:

i) Generic type(s) of the main active constituent(s) in the admixture.

ii) Whether or not the admixture contains chloride and if so, the chloride content of the admixture expressed as a percentage of chloride ion by mass of admixture.

iii) Where more than one admixture is used, confirmation of their compatibility. Producer's responsibilities: The producer of Ready-mix concrete has the following responsibilities

i)The concrete producer is responsible for the concrete slump as specified for a period of 30 minutes after the requested time or the time truck arrives at the placement site, whichever is later.

ii) The concrete producer is required to deliver concrete at the requested slump and air content, within the accepted tolerances, as measured at the point of discharge from the transportation unit. Note: The purchaser shall not alter the quality of concrete by any addition or modification at the job site. These include addition of water, admixture, fiber or special products into the ready-mix concrete supplied by the producer; in case the purchaser does this, then producer is not responsible.

1.6 GENERAL INFORMATION ABOUT RMC FACILITY

1.6.1 Location of RMC Plant

The RMC plant from where the concrete is being procured by the purchaser/user can be a commercial plant owned/operated by a third party or a captive plant owned and operated by the contractor.

In the case of commercial plants, the location is already decided as they are operational plants, and the user of RMC has no control on its location. The nearness to the site and availability of good haul roads can be the deciding factors in such cases.

However, when the RMC plants are captive plants and are erected on their site the constructor/user has to see the location of plant is suitable from all the considerations, the factors to be considered while deciding the location of plant can be.

1) Availability of land
2) Availability of Raw materials such as sand, aggregates, cements, fly-ash etc. and their leads.
3) Availability of Electric power
4) Availability of water
5) Nearness to site
6) Nearness to village
7) Environmental concerns; waste management, dust and noise control, safety etc. Hence, it is necessary that the owner of captive batching plant takes a judicious decision by considering all the above factors with respect to their technical and financial viability.

1.7 Components of RMC plant RMC plant/facility has in general the following components

1.7.1 PROPERTIES OF FRESH CONCRETE

1.7.1.1 Workability of concrete

Workability is a broad term which encompasses a range of properties of fresh concrete such as consistency (fluidity) , mobility (ability of concrete to move around the reinforcement and in restricted areas), compatibility, finishibility and pumpability (for pumped concrete). The degree of workability varies depending upon the type of construction and method of placing, compacting and finishing. Workability is measured in terms of slump of concrete using the standard procedure laid down in IS 1199:1959. The IS 456 provides guidance on the range of workability requirements for different placing conditions and applications. Consistency of fresh concrete is considered to be a close indication of its workability and slump test has been the most widely used test for ascertaining consistency and hence workability. For applications requiring very high slumps (higher than 150mm) the IS 9103 recommends use of flow table test. For a majority of concrete supplied by RMC producers, slump test is the most commonly used test. The IS 4926 specifies the following tolerance limits of workability as criteria for acceptance.

i) Slump: + 25 mm or + 1/3rd of the specified value whichever is less.
ii) Compacting factor: + 0.03 For specified value > 0.9 + 0.04 For specified value < 0.9> 0.8 + 0.05 For specified value > 0.8
iii) Flow Table Test: Acceptance criteria to be established between the producer and the purchaser.

The test for workability needs to be performed upon discharge from producer's delivery vehicle on site or upon discharge into the purchaser's vehicle. On some occasions, lack of preparedness on the part of purchaser at construction site may result in delay of placement. RMC producer will be responsible for maintaining the slump within the permissible range for a period of 30 minutes starting from arrival of transit mixers at job site. However, after 30 minutes, the IS 4926 clearly states that the responsibility for delay passes on the purchaser. Slump of concrete is quiet sensitive to a variety of environmental and other factors such as concrete temperature, ambient temperature, surface rate of evaporation, changes in grading, batch mass differences, admixture dosage, presence of mineral admixtures or otherwise, variation in air content, variation in testing, etc.

1.7.12 Density of concrete

The plastic density (unit weight) of conventional normal-weight concrete varies depending upon the variation in the density of different ingredients, the amount of entrapped air and entrained air (if air –entraining agents are used), the maximum size of aggregate and water and cement contents in the mix. Increasing the aggregate volume and reducing the cement paste would increase the density of concrete. Ready Mixed concrete is measured on the basis of volume. The volume of fresh concrete can be determined by dividing the total weight of all batched materials by the unit weight or plastic density of concrete determined in accordance with IS 1199. Sometimes there is likelihood a discrepancy in the concrete ordered and that actually supplied. Also, it should be understood that the volume of hardened concrete may be or appear to be less than expected. There could be variety of reasons for this discrepancy. These include wastage and spillage of concrete, over excavation, miscalculation in form volume, deflection or distortions of forms, settlement of wet mixes, loss of entrained air, etc. Such difference can be reconciled if plastic density of concrete is monitored regularly. While carrying out mix Proportioning, the plastic density of designed (Proportioned) mix is measured and tallied with the theoretical density. It would be a good practice to measure the plastic density at regular interval so as that the quantities supplied match orders.

The plastic density measurement can be done by filling a container of known volume with fully compacted concrete and taking the mass of concrete in that volume by following procedures detailed in IS 1199. Additionally for concrete of Road and Bridge work the guidelines given in section 1717.7.3 and 1717.7.4 of MORT&H specifications published by IRC (Fifth revision) 2013.

1.7.1.3 Air content of fresh concrete

In most parts of India, tropical weather prevails, necessitating adoption of adequate precautionary measures associated with hot weather concreting practices. Absence of adequate measures may lead to rapid loss of workability, accelerated stiffening of concrete, poor compatibility and finishibility, and cracking of concrete owing to plastic and/or thermal shrinkage. To avoid adverse effect of hot weather, both RMC producer and the purchaser need to take adequate precautionary measures. It shall also be noted that generally retarding effect of retarder is smaller at higher temperatures and sometimes few retarders seem to be in-effective at extremely high temperatures. Thus, it is desirable to keep the temperature of concrete as low as possible. Although in the IS 4926:2003 the requirements of temperature of concrete has been deleted it is advisable that the temperature of concrete produced shall not be less than 50 C and shall not exceed 350 C Additionally for concrete of Road and Bridge work the guidelines given in section 1708.5 and 1715.6 of MORT &H specifications published by IRC (Fifth revision) 2013 shall be referred to.

As far as RMC is concerned, design the concrete mix using a combination of OPC and supplementary cementitious materials or blended cement for reducing the heat of hydration as approved by SBI/APMCF. The aggregate stockpiles in the plant should be covered to avoid direct exposure to sun and water should be sprinkled on the stockpile to bring down the temperature. Some RMC producers use chilled water or ice flakes to bring down the temperature of mixing water during hot summer months. Covering the drum of transit mixer by hazien cloth helps in maintaining the temperature of concrete during transit. The requirements of extreme weather (hot weather conditions) concreting are given in IS 7861(part 1):1975 and shall be referred to.

1.8 PROPERTIES OF HARDENED CONCRETE

1.8.1 Strength of concrete

a. Concrete Cubes: - When strength of concrete is used as a basis for acceptance of concrete, which is generally adopted parameter, the standard specimen shall be made, cured and tested at 28 days in accordance with IS 516.The compliance shall be assessed against the requirements of IS 456. The testing frequencies and sampling shall be as per para 9.0 – sampling and testing of concrete of this guideline. While the strength at 28 days has emerged as a basis for contract specification; in order to get relatively quicker idea of the quality of concrete, compressive strength at 7 days may be carried out; however, it is important to establish a relationship between early age and 28 days strength for a particular concrete. But in all cases 28 days compressive strength shall alone be the criteria for acceptance or rejection of concrete.

b. Concrete Cores: - The most widely accepted method of determining the in-place compressive strength of concrete in existing structures, pavements and linings is the testing of core specimens obtained by drilling with a diamond core bit. While core strength tests are more reliable than the less expensive & less tedious non-destructive test methods now in use, the results can be affected by many structure and testing variables which must be controlled or taken into consideration while evaluating the concrete strength. Where possible, a length to diameter ratio L/D of 2 should be used but the diameter of core should be at least three times the nominal maximum size of coarse aggregate (MSA) and in no case shall the diameter of specimen be lower than twice the maximum nominal size of aggregate (MSA). Any specimen intended for strength testing shall not contain embedded reinforcing steel. Testing variables includes considerations such as method of end preparation. Often sawing is necessary to thin cores so that ends are perpendicular to the axis of the core, to eliminate reinforcing steel or honeycombed areas or to eliminate surface irregularities. Usually, cores shall be capped to produce the required plainness for testing and it shall be ensured that good practices of capping are followed as per IS 516. The capping shall be thin with a strong material. The use of thick caps or ones that are not properly bonded to the specimen or are made with a weak material may cause markedly reduced core strengths specially in short cores of L/D less than 2.0.

Shorter cores with L/D less than 2.0 give a higher indicated strength which

increases as L/d decreases; therefore, these higher strengths must be corrected by a factor (correction factor) given in IS 516 for each ratio which, on the average, will produce a corrected strength on a parity with the standard L/D = 2.0 specimen. The equivalent cube strength of the concrete shall then be determined by multiplying the corrected cylinder strength by 5/4.
A1.8.2 acceptance criteria for concrete a. Cubes the IS 456:2000 provides guidance on the acceptance criteria of concrete based on compressive strength and shall be adhered to. Accordingly, i. The test results of the sample shall be average of the strength of the three specimens. The individual variation should not be more than + 15% of the average. If more, the test results of the sample are invalid. ii. The concrete shall be deemed to comply with the strength requirements when both the following conditions are met the mean strength determined from any group of four consecutive non overlapping test results complies with appropriate limits in column 2 of Table 1. Any individual test result complies with the appropriate limits in column 3 of Table 1.

Table1: Characteristic compressive strength compliance Requirement

Specified Grade	**Mean of the group of 4 Non over lapping consecutive test results in N/sq.mm**	**Individual test results in N/sq. mm**
M15	> or equal to fck+ 0.825x established standard deviation (rounded off to nearest 0.5 N/sq mm) or fck +3 N/sq mm whichever is greater.	> or equal to (fck– 3) N/sq mm
M20 And Above	> or equal to fck+ 0.825x established standard deviation (rounded off to nearest 0.5 N/sq mm) or fck +3 N/sq mm whichever is greater.	> or equal to (fck– 3) N/sq mm

Additionally for concrete of Road and Bridge work the guidelines given in section 1717.7 of MORT &H specifications published by IRC (Fifth revision) 2013 shall be referred to.

Table 2: Assumed Standard deviation.

Grade of Concrete	**Assumed Standard Deviation N/sq.mm**
M10	3.5
M15	
M20	4.0
M25	
M30	5.0
M35	
M40	
M45	
M50	

b. Cores The IS 456:2000 gives the acceptance criteria for the core test on concrete. Accordingly, Concrete in the member represented by a core test shall be considered acceptable if the average equivalent cube strength of the cores is equal to at least 85% of the cube strength of the grade of concrete specified for the corresponding age and no individual core has strength less than 75%.

1.9 QUALITY AUDITS & Q.C. TECHNIQUES

1.9.1 General

RMC is both a service and a product. It is essential that the user is assured of quality of concrete received from RMC producer/plant. To maintain the quality & to have the quality assurance the following measures can be taken:

1) Quality Audit
2) Internal quality audits
3) Custom Techniques or its variants.

1.9.2 Quality Audit

The RMC production facility/plant shall be audited by Third party audit on annual basis. In such case the owner and the auditors are involved in an audit called as appraisal – that is someone other than the owner or purchaser is to decide whether the owner/production plant can
be certified as meeting prescribed quality standards/norms. In India, RMCMA having its office in Mumbai which has developed regulatory framework based on RMC quality schemes in developed countries and which have certified /accredited quality auditors used to carry out the third-party audits of RMC and they had audited and certified around 250 RMC plants at 45 locations in India. Recently this scheme was upgraded by RMCMA and scope enlarged by making the scheme truly third-party certification scheme. The scheme is owned jointly by Quality Council of India (QCI) and Building Materials & Technology Promotion Council (BMTPC) and they have developed a document – Criteria for RMC production control –Basic level certification for production control of RMC, the draft of which is under wide circulation and finalization. Hence, QCI-BMTPC can be contacted for third party audit of RMC plants. Additionally, there can be external audit called as second party audit, where in the purchaser of RMC or his representative will decide whether the plant/ RMC production facility is well/ enough organized to be able to meet their requirements as per quality standard

1.9.3 Internal quality audits

Internal quality audit also called as First party audit in which the owner of RMC plant or the same group will help the plant meet and improve on its own quality standards. For this, each RMC plant shall preferably develop its own QA-QC plan and documentation. Each plant Owner/producer can develop its own quality norms over and above the provisions in Indian Standards. The RMC producer shall bear in mind that there is always the scope for continuous improvement in quality and should strive for it. There shall be a system for reporting on quality parameters to the organization; for that there shall be norms and well-defined practices to monitor and control quality of input and output materials. The QA-QC plan incorporated as internal quality audit shall consists of information such as source & properties of all ingredients of concrete; Mix design; process control; information on fresh and hardened properties of concrete; statistical analysis of results etc.

1.10 ENVIRONMENTAL CONCERNS AND SITE SAFETY

1.10.1 Site Safety

As in all civil engineering constructions, at the RMC plant safety shall be given a paramount importance and “Safety first” rule shall be followed. Ready Mixed Concrete plants are industrial operations relying on heavy equipment and vehicles with potential for accidents. So, safety of workers should be a critical objective. All guardrails and machinery guards shall be fixed securely in position and walkways kept clean and with clear access. The facility shall provide suitable communication system between batching plant operator, transit mixer and delivery site. The RMC producer shall provide working conditions which have regard to the health and safety of employees. Plant should adopt a written safety program that includes formal safety training and provide incentives for workers who maintain safe practices. The following arrangements shall be ensured from safety point of view.

i Earthing arrangement: RMC equipment essentially needs to be earthed in view of abundant use of metal. Necessary earthing facility needs to be created by the owner/producer.

ii Air conditioning: Control unit of the RMC plant needs to be kept air-conditioned for trouble free running of computer systems and to provide good environment to the operators and staff.

iii Plumbing and drainage work: Water supply network needs to be laid at site for availability of water at different locations. Similarly, site drainage for rainwater or spillages need to be provided to keep it workable.

1.10.2 Environmental Considerations

Due regard shall be given to the environment in any RMC production facility. The technologies used shall be such that to reduce the environmental impact to the lowest realistic level at the same time the technologies shall be proven, economic and reasonable. The RMC facility shall endeavor that plant operations are well landscaped and screened from the surrounding residential or rural community such that the impact is minimal. The producer shall ensure that the traffic routes chosen are such as to avoid congested and sensitive areas wherever practicable and to minimize the fuel consumption. Concrete spillage on the public highway roads and pathways shall not be there. On the rural roads the dust menace shall be reduced by watering the

pathways/roads near the rural community/site. As concrete producers in RMC plant the producer shall be aware and know the details of responsibilities regarding the environmental regulations such as Air Quality
Permits; Discharge permits; Storm water management, clean water permits, Solids management, Hazardous waste regulations, Dust control, Recycling, reuse and sustainability.

1.10.3 Air and Noise Pollution and Vibration

Particulate matter emissions to air, also known as dust emissions, are the major air quality concerns at the ready mixed plant site. These very small particles can pose a health and safety risk to persons who may inhale those particles. The dust emissions can be process (point source) emissions and fugitive emissions. Process or point source emissions occur at discrete and definable locations during various activities such as silo filling; material handling and stacking; truck batching etc. Fugitive dust emissions are difficult to pin point and may arise from onsite vehicle movement, loading/transfer activities. The dust emissions can be reduced by plant enclosures and dust suppression wherein water is sprayed at the source of dust to prevent it from becoming airborne. There are many techniques and strategies available and the producer shall utilize appropriate technology to prevent or minimize dust emissions in line with local and national regulations. Noise is defined as “unwanted sound’’ and is primarily a concern of surrounding community and plant employees. While sound is inherent to RMC facility there are many areas where noise can be minimized, and the producer should take steps to ensure that plant and vehicle noise are minimized through plant designs, landscaping, berms and sound walls, and through the use of appropriate technology and strategies.

1.10.4 Fuel, Oil and chemical spillage the risk of leaks and spills can be minimized by proper design of storage facilities. The producer shall take appropriate measures and employ best management strategies to prevent leaks and spills and prevent pollution of surrounding areas and ground water by accidental effluent discharges and fuel, oil and chemical spillage.

1.10.5 Waste management Waste is defined as materials disposed of in an unproductive manner for example being land filled or discarded in a quarry or back lot. Comprehensive waste management and programs will reduce environmental burden of waste disposal. Re use of the waste material alleviates the burden of raw materials extraction. Excess concrete and returned concrete mainly forms the solid waste in RMC industry and forms the major waste concern. The producer shall introduce processes, strategies and practices that minimize the production of waste.

1.10.6 Training It is the responsibility of RMC producer to ensure that the employees/workers are properly trained and educated in safe handling of materials, hazardous chemicals and responsibility towards the environment. The producer shall give high priority to site care and good housekeeping along with participation of local community. It is also essential that emergency response procedures be established and employees be made familiar with the procedures. A formal training plan shall be prepared and implemented. Drivers play a key role in fuel management. Training to drivers can improve fleet efficiency and reduce spillage and leaks

1.11 LIST OF REFERRED STANDARDS & LITERATURE

INDIAN STANDARDS	Title
IS 383 : 1999	Coarse and fine aggregates from natural sources for concrete— Specification (third revision)
IS 456:2000	Plain and reinforced concrete— Code of practice (fourth revision) (Reaffirmed 2005)
IS 457:1957	Code of practice for Plain and reinforced concrete for Dams & other Massive structures.
IS 516:1959	Method of test for Strength of concrete.
IS 1199: 1959	Methods of sampling and analysis of concrete.
IS 1343:2012	Code of practice for prestressed concrete
IS 1791:1985	General requirements for batch type concrete
IS 2386(Part I):1963	Methods of test for Aggregates for concrete, Part I: particle size and shape, (Reaffirmed 2007)
IS 2386(Part III):1963	Methods for test for Aggregates for concrete, Part III: specific gravity, Density, Voids, Absorption and Bulking (Reaffirmed 2007)
IS 2430:1986	Methods for sampling of Aggregates for concrete(First Revision),(Reaffirmed 2005)
IS 3812(Part 1):2003	Pulverized fuel Ash For use on Pozzolana in Cement, Cement Materials and concrete
IS 3812(Part 2):2003	Pulverized fuel Ash For use on Admixture in Cement, Cement Materials and Concrete
IS 4082:1996	Recommendations on stacking and storage of construction materials and components at site (second revision)
IS 4634:1991	Methods for testing performance of batch-type concrete mixers (first revision)
IS 4925:1968	Specification for concrete batching and Mixing
IS 4926:2003	Ready Mixed Concrete – Code Of Practice
IS 5816:1999	Splitting tensile strength of concrete Method of
IS 5892:2004	Specification for concrete transit mixers and
IS 7861 (Part I):1975	Guidelines for concreting in Extreme weather conditions (Hot weather conditions)
IS 8142: 1976	"Method of test for determining setting time of concrete by penetration resistance.
IS 9103: 1999	Concrete admixtures—Specification (first revision) (Reaffirmed 2004)

WORKMANSHIP

CLEARING OF SITE, EXCAVATION AND EARTH FILLING

Note: Workmanship for all items related to the construction work should be as per relevant I.S. Code.

General:

Trenches for wall foundations, column footings, raft foundations, pile caps, plinth beams, water tanks, cess pits, etc., shall be excavated to the exact length, width and depth shown in the figure on the drawing or as may be directed by the Architect. If taken out to greater length, width or depth than shown or required, the extra work occasioned thereby shall be done at the Contractors own expenses. Extra depth shall be brought up by plain cement concrete filling 1:4:8 proportion and extra length and width filled in by rammed earth or murum or if the Architect thinks it necessary for the stability of the work by 1:4:8 concrete, as may be directed by the Contractors costs.

Excavated material shall be used for filling in plinth, or each side of the foundation blocks or trenches or it shall be spread elsewhere on or near the site of work including watering, ramming and consolidating or carted away from site free of charge, as may be ordered. The Contractor shall at his own expenses and without any extra charge, make provision for supporting all utility services, lighting the trenches, separating and stacking, serviceable materials neatly, shoring, timbering, stuttering, bailing out of water either sub-soil or rain water including pumping at any stage of the work. Trenches shall be kept free of water while masonry or any concrete works are in progress and until the Architects consider that concrete is sufficiently set.

Excavation excluding in Hard Rock:

Excavation shall be carried out in any type of soil, murum (soft or hard), soft rock, boulders, old foundation, concrete asphalt or stone paved surfaces, old masonry or concrete (plain or reinforced).

Excavation in Hard Rock:

Rock which is in solid beds, which can only remove either by wedging or chiseling shall be treated as hard rock. A boulder or detached rock measuring one cubic meter or more, shall wedging or chiseling.

Where hard rock is met with the blasting operations is considered necessary, the Contractor shall intimate about the same to the Architect.

The Blasting shall not be permitted in any case and contractor have to carry out hard rock excavation in hard rock by means of Wedging and chiseling only.

Excavation shall be done by wedging or chiseling and it shall be restricted to the quantity required to enable the necessary foundation etc. to the put in. In case, the dimension of trenches exceeds those shown in drawings or as directed by the Architect, the excess quantity shall not be paid for, the item also covers bailing out subsoil or rain water including pumping at any stage of work, shoring strutting, etc.

Earth Filling:

General: Filling shall be done with good earth, murum, stone chips, or disintegrated building debris. It shall be free from salts, organic matter, black cotton or slushy earth and combustible material. All clods shall be broken.

a) **Filling in Plinth** :

Filling shall be done in layers not exceeding 25 cm., amply watered and consolidated by ramming with iron or wooden rammers weighing 7 to 8 kgs. and having base 20 cm. Square or 20 cm. diameter. When the filling reaches the finished level, surface shall be flooded with water for at least 24 hours, allowed to dry and then rammed and consolidated, after making good any settlement in order to avoid settlement at a later stage. Special care shall be taken to pack earth under plinth beams and column corners. Finished level of filling shall be kept to a slope intended to be given to the floor.

b) **Filling in Outdoor portions and for Site Development**:

Shall be done in layer of 30 cm. Each layer shall be adequately watered. When filling reaches the required level the top most layer shall be dressed to proper section,

grade and camber and rolled by 8 to 10 ton's power roller and adequately watered to aid compaction.

DRY RUBBLE PACKING & LEVELING COURSE.

Dry Rubble Packing: Ground shall first be leveled up and thoroughly consolidated by means of heavy log hammer or frog rams. Rubbles of specified thickness shall then be laid and set with hand. It shall be consolidated by either hand roller or wooden log hammer; free use of water being made during consolidation. All hollows and interstices after consolidation shall be filled up with quarry spalls, stone chips etc., and the packing blinded with stone grit and watered and consolidated by log hammer.

Rubble packing in Road work shall be thoroughly consolidated by means of power rollers of 8 ton's capacity instead of log hammers and the surface shall be brought to proper grade and camber. After checking the level, grade and camber the surface will again be watered and rolled to receive road structure.

Leveling Course:

It shall be either plain cement concrete of leaner mix or lime concrete which shall be proportioned as stipulated in the relevant item and mixed and placed in position confirming to line and level show on the drawing and compacted by approved means and cured adequately.

Lime concrete shall be prepared by mixing sand and slaked lime in proportion of three parts of sand and one part of lime and ground in a suitable mill and the mortar so prepared shall be added to six parts of the brick bat passing through 50 mm. mesh, mixed well and placed in position and compacted by approved means. The concrete shall be cured adequately.

PLAIN & REINFORCED CEMENT CONCRETE

A) VOLUMETRIC BASIS: -

General : In any case volumetric batching shall not be allowed.

Proportioning the Mix :

Design Mix shall be carried out and same shall be got approved from APMCF/SBI. If aggregates are moist allowance shall be made for bulking in accordance with IS:2386/-. Allowance shall also be made for surface water present in aggregate when computing water contents. Surface water present shall be determined by one of the field methods described in IS:2386/- (Part III).

Mixing :

All Concrete shall be mixed in an approved mechanical mixer. The mixer and mixing platform shall be suitably protected from wind and rain. Aggregates shall be accurately measured as per design mix and mixed dry along with cement, water shall be then added in measured quantity and mixing shall be continued until there is a uniform distribution of the materials and the mass is uniform in colour and in consistency but in no case shall he mixing be done for less than 2 minutes.

Hand mixing shall not be permitted in any case.

Consistency:

Quantity of water for making reinforced concrete shall be sufficient so as to ensure that concrete shall surround and properly grip all the reinforcement. The best consistency shall be that which will flow sluggishly without flattening out and without separation of coarse aggregates from the mortar. The degree of plasticity shall depend on the nature of work and atmospheric temperature and whether the concrete is vibrated or hand compacted. The slumps shall be determined by standard slump test carried out in accordance with the procedure laid down in IS:119-1959 shall be adopted for different types of work and same shall be validated as per approved Design Mix Reports.

Admixtures:

The usage of admixtures is allowed only if approved by the structural consultant and his decision in this regard shall be final.

Transportation:
Concrete shall be conveyed from the place of mixing to the place of final deposit as rapidly as practicable by methods which will prevent segregation or loss of any of the ingredients. If segregation does occur during transport, the concrete shall remix before being placed. In
no case, more than 30 minutes shall elapse between mixing the consolidation in its position.

Placing and Compacting:
Concrete shall be placed in layers of suitable thickness or in strips and compacted before initial setting commences and should not be subsequently disturbed. Method of placing shall be such as to preclude segregation and as far as practicable the placing shall be continuous. Special care shall be taken in accordance with IS:456 while laying concrete under extreme weather.

Concrete shall be thoroughly compacted during the operation of placing and thoroughly working around the reinforcement, embedded fixtures and spaded against corners of the form work and by punning, rodding, mechanically vibrating or by any other approved means. In addition, form work shall be tapped lightly by using wooden mallet at the pouring head. The number and type of vibrator to be used shall be subject to the approval of the Architects and in general immersion type vibrators shall be used. External vibrators shall also be used whenever directed.

The intensity and duration (of vibration shall be sufficient to cause complete settlement and compaction without any stratification of successive layers or separation of ingredients or formation of laitance. Vibrator shall be inserted vertically in the concrete at points not more than 45 cm. apart and withdrawn very slowly when air bubbles no longer come on the surface. Over vibration or vibration of very wet mixes is harmful and should be avoided. Care shall be taken to utilize the vibrator only to compact the concrete and not to spread it, sufficient number of reserve vibrator in good working condition shall be kept on hand at all times, so as to ensure that there is no slackening or interruption in compacting.

Construction Joints:
Concreting shall be carried out end to end continuously as far as possible and when construction joints are totally unavoidable; it shall be located in a predetermined position approved by the Architect. The joints shall be kept at places where the shear force is the minimum and these shall be straight and at right angles to the direction of main reinforcement. When the work has to be resumed, on a surface which has hardened, such surface shall be roughened. It shall be swept clean, thoroughly wetted and covered with a 13 mm. layer of mortar composed of cement and sand in the same ration as the cement concrete mix. This 13 mm. layer of mortar shall be freshly mixed and placed immediately before the placing of the concrete.

Where the concrete has not fully hardened, all laitance shall be removed by scrubbing the Wet surface with wire or bristle brushes, care being taken to avoid dislodgment of particles of aggregate. The surface shall then be coated with neat cement grout. In horizontal joints the first layer of concrete to be placed on this surface shall not exceed 15 cm. thickness and shall be well rammed against old work, particular attention being paid to corners.

Expansion Joint:
Expansion joint shall be provided where required as shown on the drawings or as directed by the Architect / Consultant. The joints shall be filled by the approved quality filler.

Curing:
Concrete shall be carefully protected during first stage of hardening from harmful effects of excessive heat, drying winds, rain or running water. It shall be covered

with a layer of sacking, sand canvas, hessian, or similar absorbent materials and kept constantly, wet for ten days from the date of placing of concrete. Alternatively, the concrete being thoroughly wetted and covered by layer of approved water-proof material which should be kept in contact with it for seven days.

Form Work:
The form work shall conform to the shape, lines and dimensions as shown on the plans and be so constructed as to remain sufficiently rigid during the placing and compacting of the concrete and shall be sufficiently watertight to prevent loss of cement slurry from the concrete. Form work or centering shall be constructed of steel or timber and adequately designed to support the full weight of wet concrete without deflection and retain its form during laying, ramming and setting of concrete. Timber used shall be properly seasoned so as to prevent deformation when wetted.

All props shall be straight and of full height and no joints shall be allowed. Props shall be braced with thin bamboos or wooden battens and where additional staging is necessary, extra care shall be taken to use bigger diameters props with bracing at 4 or 5 levels. All props shall be supported on sole plates and double wedges. At the time of removing props these wedges shall be gently eased and not knocked out.

All rubbish, chippings, shavings and saw dust shall be removed from the interior of the forms before the concrete is placed and the form work in contact with the concrete shall be cleaned and thoroughly wetter or treated with non-staining mineral oil or any other approved materials is kept out of contact with the reinforcement.

All form work shall be removed without shock or vibration and shall be eased off carefully in order to allow the structure to take up its load gradually. Forms shall not be disturbed until concrete has adequately hardened to take up superimposed load coming on it and in no circumstances shall forms be struck until the concrete may be subjected at the time of
striking.

In the normal circumstances (generally where temperatures are above 21 degrees centigrade) and where ordinary cement is used, forms may be struck after expiry of following periods:

a)	Walls, Columns and Vertical sides of beam}	48 hours
b)	Bottom of slab up to 4.5 m. span.	7 days.
c)	Bottom of slab up to 4.5 m. span.	14 days.
d)	Bottom of beams and arch rib over 6 m. span.	21 days.

However, this period may be increased or decreased at the discretion of Architects. Special care shall be taken while striking the centering of cantilevered slab canopies, portal frames, folded plate construction and period of striking centering shall be as determined by the Architect. If directed, form shall be given an upward camber to ensure that the beams do not have any sag. Surface that becomes exposed on removal of forms shall be carefully examined and any fins, burrs, projections etc., that are detected shall be removed. Any honeycombing of minor nature shall be finished neatly with cement mortar 1:2.

Any work showing signs of damage through premature or careless removal of centering or shuttering, shall be reconstructed by the contractor at his own cost.

Strength:
Concrete mixed in the proportion desired shall have compressive strength after placing, not less than the following:

Concrete mixed in the proportion desired shall have compressive strength after placing, not less than the targeted strengths as per requirement.

Tests:
Tests on concrete shall be carried out in accordance with IS-456/- and any other is

applicable. The frequency of work test shall be at such intervals as ordered by the Architect and subject to that every 150 cu.m. of concrete placed or part thereof and for a day's concrete exceeding 30 cu.m. a batch of 6 cubes shall be made for every sample and 3 of them tested after 7 days and the remaining 3 cubes shall be tested after 28 days. The criteria for acceptance of a concrete as confirming to a specified proportion / grade of concrete shall be in accordance with IS:456 and the Contractor shall entirely re-do the rejected work at his own cost. Strength of 28 days shall alone be considered for acceptance.

The Contractor shall arrange to carry out the tests in accordance with the relevant Indian Standards Specifications in an approved laboratory and the test reports in original be submitted to Architect. The entire cost of testing shall be borne by the Contractor.

Steel Reinforcement:
Reinforcement shall be accurately fabricated, placed and adequately maintained in position as shown on the drawings or as directed by the Architect. All finished bars shall be free from cracks, surface flaws, laminations, jagged and imperfect edges. Cement mortar blocks shall be used to give requisite cover as shown be firmly tied with binding wire of 16 to 18 gauge. Reinforcement shall be bent in accordance with the procedure stipulated in IS:2502-1963 and will not be straightened in a manner which will injure the material.

All reinforcement shall immediately before placing in concrete be thoroughly cleaned of loose mill scale, loose rust, oil and grease or other deleterious matter that would destroy or reduce bond. Reinforcement in reinforced concrete members shall not be connected by welding or coupling except in accordance with relevant ISS and with the previous approval of the Architect. Overlaps and joints shall be staggered and located at points, along the spans where neither shear nor bending moment is maximum.

Cover:
Reinforcement shall have cover as shown on the R.C.C. drawings and where not specified the thickness of cover shall be as follows.

a) At each end of reinforcing bar not less than 25 mm. not less than twice the diameter of such rod or bar.

b) For a longitudinal reinforcing bar in a column not less than the diameter of such rod or bar. In the case of columns of minimum of 20 mm. or under whose reinforcing bars do not exceed 13 mm. the cover of 25 mm. may be used.

c) For longitudinal reinforcing bar in a column not less than 25 mm. not less than diameter of such rod or bar.

d) For tensile, compressive, shear or other reinforcement in a slab not less than 13 mm. nor less than diameter of such reinforcement, and

e) For any other reinforcement not less than 13 mm. not less than the diameter of such reinforcement.

BRICK AND STONE MASONRY
General:
All brick work should be carried out as shown on the drawings with setbacks, projections, cuttings things, etc. Wherever the proportion of cement mortar has not been specifically mentioned, cement mortar in the proportion of 1:6 shall be used. Flat bricks arches shall be provided wherever required without any extra cost. Brick work shall be kept wet while in progress, till mortar has properly set. On holidays or when work is topped, top of all unfinished masonry shall be kept wet. Should the mortar become dry, white or powdery, for want of curing work shall be pulled down and rebuilt at the Contractor's expenses.

Brick Work 1stClass:
Bricks shall be thoroughly cleaned, well wetted and soaked for at least twelve hours in fresh water before being used on the work. Bricks shall be of locally, available best quality. English bond shall be used throughout in walling. A good bond shall be maintained throughout the work, both laterally and transversely. In walling, the courses

shall be kept perfectly horizontal and in plumb with the frogs facing upwards. Vertical joints shall not exceed 10 mm. thickness and shall be full of mortar. No broken bricks shall be used except as closers. After day's work all joints shall be raked to 12 mm. depth to provide for proper key to plastering.

Mortar used shall be as specified in respective items and every third course of brick work shall be flushed with mortar grout.

Whole of the masonry work shall be brought up at one uniform level throughout the structure; but where breaks are unavoidable, joints shall be made in good long steps. All junctions of walls and cross walls shall be carefully bounded into the main walls. The rate of laying masonry may be up to a height of 60 cm. per day if cement mortar is used and 45 cm. Per day if lime mortar is used. Greater heights may be built only if permitted by the Architect. During rains, the work shall be carefully covered to prevent mortar from being washed away. Should any mortar or cement be washed away, the works shall be removed and rebuilt at the Contractor's expenses.

Bricks Work 2ndClass:
Shall be similar to 1st class brick work except that 2nd class bricks shall be used and joints shall be 10 mm. t0 12 mm. thick.

Half Brick Masonry:
Shall be set in cement mortar as specified. Hoop iron bands of 2.5 cm. x 0.16 (1" x 1/16") shall be embedded in every fourth course with thick mortar band or 2 Nos. 6 mm. (1/4") dia. bars shall be used in every sixth course otherwise as specified under item.

RUBBLE MASONRY
General:
Stones shall be of the kind specified in the item and shall be from an approved quarry. Stones shall be well wetted before laying in position. The mortar shall be as specified in the item. Face stone shall not be less than in breadth than in height, it shall also tail into the work more than its height. Jambs of doors, windows and openings shall be formed with quoins. In case of battered walls, the courses on battered surface shall be at right angle to the batter.

Through stones or headers shall be laid in every course at a distance not exceeding 2 meters part and shall be staggered. They shall be in one piece for walls up to 1.5-meter width and shall be lap jointed in case of wall having thickness more than half meter. The face area of each header shall not be less than 0.50 sqm. 1:2:4 cement concrete may also be allowed where good length headers are not available. Headers shall be marked with oil paint for ready identification.

Height of quoins shall be same as that of the course. Length of quoins shall be 0.50 m. and shall be laid header and stretcher alternatively. Faces of quoins shall be fair dressed. No quoins stones shall be less than 0.30 cum. In content. Joints of masonry shall be raked out and unless otherwise stated, shall be raised cement pointed by using cement mortar 1:1 to all exposed surfaces. All masonry work shall be well watered for a period of seven days.

a) Coursed Rubble Masonry – First Sort:
Height of course shall not be less than 15 cm. and all courses shall be of uniform height. All stones in the course shall be of same height. In no case height of course shall be more than any of the course below it. Bed and sides shall be hammer or chisel dressed back from the face 75 mm. and 35 mm. respectively.

Faces of stones shall be hammer dressed and bushing shall not be more than 35 mm. Thickness of joints shall not be more than 10 mm. Stones shall break joints at least half the height of the course. Work on interior face shall be precisely the same, as on exterior face. Quoins shall be at least 0.5 m. long laid square on their beds and shall be fair dressed to a depth of at least 10 cm.

b) Uncoursed Rubble Masonry:
Stones shall be hammer dressed. Nearly fifty per cent of stones shall not be less than 0.30 cum. in content each, and twenty-five per cent of stone shall tail back in masonry by

40 cm. or more. Stones shall be so arranged as to break joints as much as possible.

Long vertical joints shall be carefully avoided. Thickness of joints shall in no case exceed 12 mm.

Pillar offsets shall be properly dressed with hammer or chisel to form proper angle. Stones used for the backing shall be of fairly large size.

c) Random Rubble Masonry – First Sort:
Stones shall be roughly chisel dressed. They shall be solidly bedded in mortar. Height of stone shall not be more than width of face or length of tail. Stones shall be of equal size and so arranged as to break joints as much as possible, avoiding long lines of horizontal or vertical joints. Quoins shall be same as described in Coursed Rubble Masonry – 1st Sort. All stones shall be carefully fitted. Thickness of face joint shall be not exceeded 25 mm. Edges of stones shall be chisel dressed for fitting in position properly.

Timber used shall conform to specifications described under Materials, Doors, Windows, Ventilators, walls, Paneling, False Ceiling, etc., shall be in accordance with Architect's drawing in every detail and all joiner's work shall be accurately set out, framed and finished in a proper workman-like manner, frames of doors, windows and ventilators etc. and shutter styles and rails shall be best solid teak of quality specified in the schedule of quantities. The scantlings shall be accurately planed smooth, rebates, rounding and mouldings shall be made as shown on the drawings, patching or plugging of any kind shall not be allowed. Joints shall be simple, neat and strong. Framed joints shall be coated with suitable adhesive like glue or synthetic resin before the frames are put together. All mortise and tenon joints shall be fit and fully and accurately without wedging on filling. The joints shall be pinned with hard wood or bamboo pins of 10 mm. to 12 mm. dia. or rust resisting star shaped metal pins 8 mm. after the frames are put together and pressed in position by means of press. The frames are put together and pressed in progress of work by suitable boxing. All portions of timber abutting against or embedded in masonry or concrete shall be treated against termites by giving a coat of any approved wood preservative.

Unless otherwise specified all doors, frames shall have six M.S. flat hold fasts and window frames shall have four hold fasts shall be provided to the ventilators, if directed. Size of hold fasts shall be 30 mm. x 40 mm. x 6 mm. M.S. flat bent to shape worth fish tail end and it shall be fixed to frame with sufficient number of screws as directed. When door / window frames are to be fixed to R.C.C. column or R.C.C. wall, hold fasts shall be substituted by suitable arrangements such as coach crews, rawl bolts etc., to secure frames to R.C.C. column or R.C.C. wall as directed by the Architect.

Frames and shutter shall not be painted or erected before being approved by Architect.

Paneled Shutter:
Panels shall be of pattern and size as shown on the drawings or as directed by Architect. Solid teak wood panels shall be in one piece wherever possible. Where two or more pieces are permitted, they shall be of equal width. Panels shall be framed into grooves made in styles and rails to the full depth of groove and faces shall be closely fitted to sides of groove.

Where panels specified are block board, it shall be solid core with teak internal lipping and of approved make.

Partly paneled and partly glazed shutter shall be similar to paneled shutters except that such parts as are directed shall be glazed with plain or ground glass as specified. Styles and rails shall be rebated 12 mm. to receive glass. Sash bars shall be moulded and rebated and mitered on sides to receive the glass which shall be fixed with putty and beads.

Hardware Fittings:
Supply and Installation of All hardware, fittings and fixtures shall be the scope of Contractor the cost of same shall be included in the rate quoted. The fixing shall be done in the best workman-like manner in accordance with the manufacture's specifications. The Contractor shall be held responsible for working of all moving parts dependent on

proper fixing. He will also be responsible for any breakage due to negligence during fixing or lack of protection before the building is handed over. The Contractor shall also take delivery of all hardware fittings etc., as and when supplied and arrange for safe storage etc.

Hardware required for fixing false ceiling, wall paneling etc., shall be arranged by the Contractor at his cost. Apart from the hardware fittings required for the joinery items, the Contractor shall have to fix all other items of hardware fittings to be supplied by the employer viz. coat / picture hooks, numerical, letters to denote buildings, hanging rods etc., as directed by the Architects.

Painting and polishing of wood work shall be as per specifications under respective heads.

Flush Doors:
All flush doors shall be solid core unless otherwise specified. It shall conform to the relevant specifications of I.S. 2202 and shall be obtained from approved manufactures. The finished thickness of the shutter shall be mentioned in the items. Face veneers shall be of the pattern and colour approved by the Architect and an approved sample shall be deposited with the Architect for reference.

The solid core shall be wood laminae prepared from battens of well-seasoned and treated good quality wood having straight grains. The battens shall be of uniform size of about 2.5 cm. width. Theses shall be properly glued and machine pressed together, with grains of each piece reversed from that of adjoining one. The longitudinal joints of the battens shall be staggered and no piece shall be less than 50 cm. in length. Alternatively, the core shall be of solid teak particle board. Edges of the core shall be lipped internally with 1st Class teak wood battens of 4 cm. (1.5”) minimum depth, glued and machine pressed along with the core.

The core surface shall then have two or three veneers firmly glued on each face. The first veneer (called cross band) shall be laid with its grains at right angles to those of the core and the second and the third veneers with their grains parallel to those of the core. The under veneers shall be of good quality, durable and well-seasoned wood. The face veneers shall be of minimum 1 mm. thickness and of well-matched and seasoned 1st class teak, laid along with grains of the core battens. The combined thickness of all the veneers on each face shall not be less than 4 mm. Thermosetting synthetic resin conforming to I.S. 303 or moisture-proof plywood grade MPF.I. shall be used in manufacture. In addition to internal lipping all doors shall have external lipping all round.

STEEL DOORS, WINDOWS, VENTILATORS, ROLLING SHUTTER, M.S. GRILLES ETC.
Steel used in the manufacture of rolled steel sections shall not have more than 0.060 per cent of Sulphur and 0.065 per cent of phosphorus. The carbon content shall not exceed 0.30 per cent and shall be of weldable quality. In all other respects, the rolled steel sections shall conform to I.S. 226-1955 and I.S. 1977-1962.

Frames shall be square and flat. Both the fixed and openable frames shall be constructed of sections which have been cut to length, mitered and electrically welded at corners. Subdividing bar units shall be tenoned and rivetted into the frames. All frames shall have the corners welded to a true right angle and welds shall be neatly cleaned off. Couplings, mouldings and weather bar shall be provided as directed by the Architects.

Outer frames shall be provided with fixing holes centrally in the web of the sections and fixing screws and lugs shall be used for fixing the frame to masonry. Mastic cement shall be used for making the joints watertight.

Hinges shall be strong projecting type. If directed friction type hinges shall be used in which case windows shall not be fitted with peg stays.

Projecting type hinged shutter shall be fitted with bronze or brass peg stays, 30 cm. Long with peg and brackets welded / riveted to the frame or as sated under item.

All windows shall be provided with handles of brass or bronze or otherwise as stated

under them. Top hung ventilators shall be fixed with plain hinges riveted / welded to the fixed frame. A brass or bronze peg stay 30 cm. long as in windows shall be provided or as stated under item.

Center hung ventilators shall be hung on two pairs of brass or leaded tin bronze cup pivots riveted to the inner and outer frames of the ventilators to permit the ventilators to swing through an angle of approximately 85. The opening position of the ventilator shall be so balanced to keep it open at any desired angle under normal weather conditions. A bronze spring catch shall be fitted in the center of the top bar of the ventilator for the operation of the ventilator. This spring catch shall be secured to the frame with brass screws and shall close into a mild steel malleable iron catch plate riveted or welded to outside of the outer ventilator frame bar. A brass cord pulley wheel in mild steel or malleable iron brackets shall be provided along with card eye.

The windows and ventilators shall be painted/Powder coated if applicable. All the steel surfaces shall be thoroughly cleaned free of rust, scale or dirt and mill scale by picking or phosphating and before erection painted with one coat of approved primer and after erection painted with two finishing coats of synthetic enamel paint of approved shade and quality.

Glazing of specified thickness shall be provided on the outside of frames and unless otherwise specified, metal beading of approved shape, and section shall be used for fixing glasses. Special metal sash putty of approved make shall be used, if directed.

Rolling Shutters:
Shall be of approved manufacture suitable for fixing in the position ordered i.e. outside, inside, on or below lintel or between jambs. Shutters up to 12 sqm. (130 Sq.ft.) in area shall be manually operated or Push Up type while bigger sizes shall be of reduction gear type mechanically operated chain or handles.

These shall be consisting of 8 gauges or as specified with 75 mm. (3”) M.S. laths of best quality mild steel strips machine rolled and straightened with an effective bridge depth of 16 mm. (5/8”) and shall have convex corrugation. These shall be interlocked together throughout their entire length with end locks. These shall be mounted on specially designed pipe shaft. The spring shall be of approved make coiled type. These shall be manufacture from tested high tensile spring steel wire or strip of adequate strength to balance the shutters in positions. The spring pipe, shaft etc., shall be supported on strong M.S. or malleable cast iron brackets.

Both the side guides and bottom rail shall be jointless and of single piece of pressed steel.

Top cover of shaft, spring etc., shall be of the same material as that of lath.

For rolling shutter with wicket-gate, night latch shall be provided free of cost.

The shutter and cover etc., shall be painted with one coat of anti-corrosive paint and two coats of synthetic enamel paint of approved quality and shade.

Collapsible Steel Gate:
It shall consist of vertical double channels at 10 cm. centers. The sizes of channels T-Section for top and bottom shall be as approved by the Architects. The gate shall be provided with necessary bolts, nuts, locking arrangements, stoppers and brass handles on both sides. The gate shall be painted with one coat of anti-corrosive paint before erection and two coats of synthetic enamel paint of approved quality and shade.

Wrought Iron Grilles:
Grille’s hall be manufactured as per drawings and the welded joints shall be smooth. The grilles shall be painted with one coat of anti-corrosive paint before fixing and two coats of synthetic enamel paint of approved quality and shade.

Aluminum Doors, Windows, Ventilators & Partitions etc.:
These shall be obtained from approved and established manufactures and shall be of Aluminum alloy conforming to I.S. 733 and sections shall generally conform to I.S. 1948.

Theses shall be fabricated as per the detailed drawings,

Frames for windows, ventilators etc., shall be square and flat. Both fixed and openable frames shall be constructed of section which have been cut to length, mitered and welded at corners. Sub-dividing bars shall be tenoned and rivetted into the frames. All frames shall have corners welded to a true right angle. For side hung shutters, hinges shall normally be of projecting type made of Aluminum alloy and rivetted / welded to frames. Handles, peg stays etc., or approved quality Aluminum or its alloy conforming to IS Specifications.

All types of shutters shall be fabricated, supplied and fixed as specified in the IS:1948. The rate shall include supplying and fixing all fittings and fixtures required for proper and safe operation.

The doors shall be fabricated by using standard aluminum alloy extruded sections as specified in IS:1948. The rate shall include supplying and fixing all fittings and fixtures including approved locking arrangement as directed.

All aluminum fabricated work shall be anodized to the British Standard 1616:1961 to give an
anodized film of 25 micron.

The Contractor shall take to stack the fabricated frames etc., on site under cover. They shall be handled with care, stacked on edge on level bearers and supported evenly. Before erecting, the frames coming in contact with concrete, masonry, plaster of dissimilar metals shall be coated with a coat of Zinc Chromate conforming to IS:104-1950. The Contractor shall cover all anodized finish work with a thick layer of clear transparent lacquer based on methacrylate or cellulosebuty rate to protect the surface from wet cement during installation. This coating shall remove on completion. Before handing over, the aluminum work shall be washed with mild solution of non-alkali soap and water.

Glazing: Glazing shall be approved especially quality glass of specified thickness and unless otherwise directed it shall be provided the exterior with metal beading.

FLOORING, SKIRTING, DADO AND STONE VENEERING
All flooring, skirting, dado and stone veneering etc., shall be executed strictly as per relevant IS Specification and in workman-like manner.

Indian Patent Stone:
Selection of materials, method of mixing, placing and compacting shall generally conform to the specifications under plain and reinforced cement concrete described earlier. A stiff mix consistent with workability shall be used.

Preparation of Surface:
Before the operation for laying topping is started the surface of base concrete shall be thoroughly cleaned of all dirt, loose particles coked mortar droppings and laitance if any, by scrubbing with coir or steel wire brush. Where the concrete has hardened so much that roughening of surface by wire brush is not possible, the surface shall have roughened by chipping or hacking at close intervals. The surface shall then be cleaned with water and kept wet for 12 hours and surplus water shall be removed by mopping before the topping is laid.

Laying:
The screed strips shall be fixed over the base concrete dividing it into suitable panels. Before placing the concrete for topping, neat cement slurry shall be thoroughly brushed into the prepared surface of the base concrete just ahead of the finish. Concrete of specified proportion and thickness shall be laid in alternate panels to required level and slope and thoroughly tamped.

Finishing the Surface:
After the concrete has been fully compacted it shall be finished by troweling or floating with neat cement rendering. Finishing operations shall start shortly after the compaction

of concrete and the surface shall be troweled three times at intervals so as to produce a uniform and hard surface. The satisfactory resistance of floor to wear depends largely upon the care with troweling is carried out. The time intervals allowed between successive troweling is very important. Immediately after placing cement rendering, only just sufficient troweling shall be done to give a level surface. Excessive troweling in the earlier stages shall be avoided as this tends to bring a layer rich in cement to the surface. Sometime, after the first troweling, the duration depending upon the temperature, atmospheric conditions and the rate of the set of cement used, the surface shall be re-troweled to close any pores in the surface and to bring to surface and to scrape off any excess water in concrete or laitance. No dry cement shall be used directly on the surface to absorb moistures or to stiffen the mix. The final troweling shall be done well before the concrete has become too hard but at such time that considerable pressure is required to make any impression on the surface.

If directed by the Architect, approved mineral pigment shall be added to the rendering to give desired colour and shade to the flooring at no extra cost.

When instead of 1:2:3 or 1:2.5:3.5 mix, 1:2:4 is specified the topping shall be rendered with 1:1 cement mortar with a suitable mineral pigment, if directed, instead of cement only. If specified in the Schedule of Quantities, the flooring shall be machine polished as per the Architect's instructions. Wherever the patent stone flooring is used as finishing on roof the joints shall be filled with an approved bitumastic filler in workman like manner.

Ironite Topping:
Instead of finishing the top with rendering coat of 1:1 cement mortar, the top shall be finished with 12 mm. thick ironite topping. Unless otherwise specified, one part of ironite and four parts of ordinary cement by weight shall be mixed dry thoroughly. This dry mixture shall be mixed with stone grit 6 mm. (1/4") and down size or as otherwise directed in the ratio of 1:2 by volume and well turned over. Just enough water shall be added to this dry mix and mixed thoroughly well and laid to uniform thickness of 12 mm. and compacted. After initial set has started the surface shall be finished as directed.

Plain and Colored Cement Tiles, Marble Mosaic and Terrazzo Tiles Flooring:

The tiles shall conform to IS : 1237 having the colour approved the Architect and the rate shall include provision of border tiles and tiles of different colours in pattern if directed. The mosaic topping of lighter shade tiles shall be made of White Cement with an approved shade pigment and neutral shade shall be of Grey cement with an approved shade pigment. The type of tiles shall be as specified in respective items.

The sub-grade shall be thoroughly wetted after cleaning of all dirt, laitance, and loose material. A bed of lime mortar consisting of one part of lime and two parts of sand shall be laid and properly leveled to an average thickness of 25 mm. and the surface shall be kept slightly rough to form a satisfactory key for tiles. Neat cement paste of honey like consistency shall be spread over mortar bed, over such area at a time as would accommodate about 20 tiles. Tiles shall be soaked in water for 15 minutes and allowed to dry for the same duration. Tiles shall then be fixed with a thin coat of cement paste on back of each tile and then each tile being gently tapped with a wooden mallet till it is properly bedded and in level with adjoining tiles. Joints shall be fine and as imperceptible as possible.

After tiles have been laid in a room or a day's fixing work is completed, surplus cement grout that may have come out of the joints may be wiped off gently and joints cleaned. A thin slurry of coloured cement matching to the colour of tiles shall be spread over it and rubbed so as to seal even a thinnest joint between the tiles and make it impervious and the flooring cured for 7 days. The tiles shall be polished and finished according to IS:1443.

Dado, Skirting and Risers:
Tiles shall conform to IS:1237 and shall be of approved design. The tiles shall be fixed near cement grout on a blacking coat consisting of 1:4 cement sand plaster of 15 mm. thick. The top and bottom junctions of tiles shall be rounded off neatly as directed. The joints shall be filled with matching shade coloured cement slurry. The surface shall be kept wet for 7 days and then polished with carborundum stone to obtain smooth surface

and fine polish.

Shahabad / Tandur / Kotah / Cuddappa Stone Flooring:
The flooring shall be either with rough stone or machine cut and machine polished as specified in respective items and shall be of specified thickness and of approved quality and size, free from cracks and flakes and shall be uniform in colour with straight edges. The sides of machine cut and machine polished stone shall have perfect right angles and surface smooth. The stone slabs shall be laid and finished as described under plain cement or colour cement tiles on a bedding of 1:2 lime mortar 25 mm. (Average) thickness. The finished stone surface thus laid shall then be polished to the required degree as approved by the Architect.

In Dado, Skirting, Risers etc.:
Stone slabs shall be laid on backing plaster of cement mortar 1:4 of 15 mm. to 20 mm. thick and finished as described under plain and coloured cement tile dado.

Marble mosaic / Terrazzo in situ work in flooring, dado, skirting etc.:
The terrazzo / mosaic finish shall be laid on an under layer of thickness as specified in the respective items. The topping shall consist of a layer of marble chips of selected sizes, colour and design approved by Architect, mixed with cement with desire shade of pigment. For lighter shade mosaic. terrazzo white cement shall be used and for neutral shade, grey cement shall be used. The proportion of terrazzo mix shall be three parts of cement one part of marble powder by weight. For every part of cement marble powder mix, the proportion of marble aggregate by volume shall be 1.5 parts unless otherwise specified. The topping shall be mixed and laid in panels as described in IS:2114 and as per decorative designs prepared by Architects. The dividing strips of panels shall be Aluminum or as specified in the Schedule of Quantities. It shall be polished as specified in IS: 2114.

Broken Mosaic Flooring:
Broken mosaic finish shall be laid on an underlayer of thickness as specified in the item. Pieces of mosaic tiles shall be obtained from broken marble mosaic tiles of approved shade conforming to IS:1257. The sizes of pieces shall be suitable to obtain the desired pattern of flooring as shown on the drawings or as approved by Architect.

Broken pieces shall be thoroughly wetted before fixing them. Ordinary or coloured cement grout shall be spread on the bedding. Mosaic tile pieces shall be fixed piece by piece to the desired pattern. The flooring shall be laid to correct level and slopes and compacted by straight screed tamper. The grout shall cream up to the surface. The junctions of the flooring and the wall shall be rounded and the flooring shall be extended along the wall to about 15 cm. (6”). After the day’s work, the surplus cement grout that may have come out of the joints shall be cleaned off. The flooring shall be cured for seven days and then polished with a machine as stipulated in IS:1443.

Broken China Mosaic:
Broken China Mosaic flooring shall be exactly as per broken mosaic tile flooring except that the broken pieces shall be of China of approved colour and manufacturer and the floor shall not be polished.

Marble Flooring:
Marble slabs shall be of the best Indian marble of White or other approved colour as specified in the item. They shall be hard, dense, uniform and homogeneous in texture. They shall have even crystalline grain and free from defects and cracks. The surface shall be machine polished to an even and perfectly plane surface and edges machine cut true to square. The rear face shall be rough enough to provide a key for the mortar. No slab thinner than the specified thickness at its thinnest part. The sizes of the slabs shall be as specified in the respective items.
The slabs shall be paid as described under mosaic tile flooring in every respect.

White Glazed / Ceramic Tiles / Vitrified Tiles in Flooring and Dado:
White Glazed Tiles from an approved manufacturer conforming to IS:777 shall be used. They shall be of specified size and thickness. All specials viz. coves, internal and external angles, corners, beads etc., shall be used wherever directed. Under layer of specified thickness and mortar of stipulated proportion shall be laid as described in

marble mosaic flooring. Tiles shall be washed clean and set in cement grout and each tile being gently 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 I straight lines or to suit the required pattern. After the tiles have been laid, surplus cement grout shall be cleaned off.

The joints shall be cleaned off the grey cement grout with a wire brush or trowel to a depth of 5 mm. (3/16") and all dust and loose mortar removed. Joints shall then be flush pointed with white cement. The floor shall then be kept wet for seven days. After curing, the surface shall be washed with mild hydrochloric acid and clean water. The finished floor shall not

PLASTERING
Scaffolding:
Scaffolding for carrying out plastering work shall be double steel scaffolding having two sets of vertical supports so that the scaffolding is independent of the walls.
Preparation of surface:
All put log holes in brick work and junction between concrete and brick work shall be properly filled in advance. Joints in brick work shall be racked about 10 mm. if not raked out while constructing brick masonry work and concrete surface hacked to provide the grip to the plaster, if not hacked earlier projecting burns of mortar formed due to gaps at joints in shuttering shall be removed. The surface shall be scrubbed clean with wire brush / coir brush to removed dirt, dust etc., and the surface thoroughly washed with clean water to remove efflorescence, grease and oil etc., and shall be kept wet for a minimum of six hours before application of plaster.

Neeru Plaster:
Cement mortar of specified proportion and thickness shall be prepared in small batches and applied to the wall surface / ceiling. The ensure proper thickness, gauged patches shall be made at 1.5 to 2 m. apart and the surface plastered true to line, level and plumb taking special care to finish jambs of windows, doors, wall returns, corners, junctions etc. A thin layer of neeru shall then be applied and rubbed into surface and finished by means of trowel until the surface is even and smooth. The surface shall be kept moist for seven days and then given a coat of white wash.

Sand-faced Plaster:
The surface shall be prepared as above.

The coat of cement mortar in proportion of 1:4 or as specified, shall be applied uniformly all over the surface to a thickness of 12 mm. and finished true to level and line and keys shall formed on the surface. The surface shall be kept moist till the finishing coat is applied.

The finishing coat shall be applied a day or two after. The proportion of mortar for finishing coat shall be one part of cement and three parts of selected, well graded and washed sand, or as specified under item and it shall be applied in a uniform thickness of 6 mm. (1/4").

The surface shall be tapped to uniform grained texture by using sponge pads as directed. Curing shall start after 24 hours and the surface kept wet for seven days.

Rough Cast Plaster:
Except for the finishing coat the surface shall be prepared and base coat of plaster applied as under sand-faced plaster.

Finishing coat mortar shall be in proportion of one part of cement and one part of specially selected and graded sand and one part of gravel of 3 to 6 mm. size. It shall be flung upon the first coat with large trowel to form an even and decorative coat. The work shall generally conform to clause 16.5 of IS:1661-1960. The thickness of the coat shall be about 12 mm.
(1/2"). It shall be cured for seven days.

Rough coat plaster with colour finish:
This finish shall be similar to Rough cast plaster above except a high-grade mineral

pigment of approved shade shall be mixed with white cement instead of ordinary grey cement while preparing the mortar.

Water-proofing Treatment :
Unless otherwise specified, the Contractor shall carry out waterproofing treatment of basements, terrace and water retaining structures through reputed firms having specialization in the line and approved by the Architects. The Contractor shall also furnish full details of such treatment to the Architects and provide all information / proof etc., regarding the effectiveness of the treatment when called upon to do so. All such treatment shall have to be guaranteed in the form approved by the Employer for a minimum period of ten years. Any defects / leakages noticed during the guarantee period shall have to be rectified free of cost by the Contractor including reinstating the surface to its original condition and finish.

Waterproofing of sunk portions of floor slabs for baths, W.C. and kitchen mories etc., in residential buildings, unless otherwise specified, shall be done as specified in the schedule and shall generally comprise of :

a) A coat of hot bitumen, min. 6 mm. thick screened with stone grit.

b) Min. 20 mm. thick cement plaster in cement mortar 1:3 with approved water-proofing cement compound as per manufactures specifications. The plaster shall be cured by pounding for seven days.

The rate for the above treatment shall include drying and cleaning surfaces free of dust etc. and wiping with kerosene before application of bitumen. The vertical faces and returns shall also be treated similarly. The actual area treated including vertical faces and returns shall be measured and paid for. The work should be done in such a way that the finished flooring in bath has a minimum slope of 20 to 25 mm.

PAINTING
General:
Wherever scaffolding is necessary, it shall be double scaffolding.

The surface shall be thoroughly brushed free from mortar droppings and foreign matter. All steel work shall be cleaned of loose rust, mill scales etc. so as to expose the original surface. All broken edges, cracks, loose plaster and wavy surface shall be brought up either by patch plaster work or by plaster of paris.

All materials viz., dry distemper, oil bound distemper, oil paint, flat oil paint, synthetic enamel paint, plastic emulsion paint, cement primer, red lead and other primers and metallic paints shall conform to respective I.S. specifications and shall be obtained from approved manufactures. All paints shall be brought on site in sealed thins in ready mixed form and shall be applied directly with the addition of thinner, if recommended by the manufacturers.

White Washing:
White was shall be prepared from lime slaked on spot, mixed and stirred with sufficient water to make a thin cream. This shall be allowed to stand for 24 hours and shall be screened through clean cloth. Four kg. gum dissolved in hot water shall be added to each cubic meter of the cream (115 gm. per cft.).

Blue shall be added to give required whiteness. The approximate quantity of water to be added in making cream shall be five liters per kg. of lime.

White wash shall be applied in specified coats by using flat brushes or spray pumps. Each coat shall be allowed to dry before next coat is applied. If additional coats than what have been specified, are necessary to obtain uniform and smooth finish, it shall be given at no extra cost. The finished dry surface shall not show any signs of cracking and peeling nor shall it come off readily on the hand when rubbed.

If directed by the Architects one coat of chalk and glue shall be applied before application of white / colour wash at no extra cost.

Colour Wash:
Colour wash shall be prepared by adding mineral colours not affected by lime to white wash. No colour wash shall be done until a sample of the colour wash to the required tint or shade has been got approved form the Architects.

Colour wash shall be applied as specified under white wash.

Dry Distemper:
Shade shall be got approved from the Architects before application of distemper.

The surface shall be prepared as specified earlier. A primer coat using approved primer or sizing shall be applied. Distemper prepared as per manufacturer's directions shall be applied and each coat shall be allowed to dry before subsequent coat is applied. The finished surface shall be free form chalking when rubbed, even uniform and shall show not brush marks. If additional coats are necessary, they shall be given at no extra cost.

Oil Bound Distemper:
The surface shall be prepared as specified above. A primer coat of either cement primer or any approved distemper primer shall be applied.

After the primer coat has dried, the surface shall be lightly sand papered and dusted to make to smooth to receive distemper.

Distemper shall be prepared as per the directions of the manufacturer and conforming to shade approved. It shall be applied in specified coats, taking care to allow for drying of each coat before subsequent coats are applied.

Water-proof Cement Paint / Sand-tex matt Paint:
The surface shall be prepared as specified above and thoroughly wetted with clean water before water-proof cement paint is applied.

The paint shall be prepared strictly as per manufacturers specifications and in such quantities as can be used up in an hour of its mixing, as otherwise the mixture will set and thicken, affecting flow and finish.

The paint thus prepared shall be applied on clean and wetted surface with brush or spraying machine. The solution shall be kept stirred during the period of application. It shall be applied on the surface which is on the shady side of the building so that the direct heat of the sun on the surface is avoided. The completed surface shall be watered after the day's work. Number of coats shall be s specified in the item.

Painting – Oil / Enamel / Plastic Emulsion etc.:
Ready mixed oil paint, flat oil paint, plastic emulsion paint, ready mixed synthetic enamel paint, etc., shall be brought in original containers and in sealed tins. If for any reason thinner is necessary, the brand and quantity of thinner recommended by the manufacturer or as instructed by the Architect shall be used. The surface shall be prepared as specified above and a coat of approved primer shall be applied. After 24 hours drying approved or specified quality paint shall be applied evenly and smoothly. A filler putty coating may be given to give a smooth finish. Each coat shall be allowed to dry out thoroughly and then lightly rubbed down with sand paper and cleaned of dust before the next cost is applied. Number of coats shall be as specified in the item and if the finish of the surface is not uniform, additional coats as required shall be applied to get good and uniform finish at no extra cost. After completion no hair marks from the brush or clogging of paint puddles in the corners of panels, angles or mouldings etc., shall be left on the work. The glass panes, floor etc. shall be cleaned of stains.

When the final coat is applied, if directed, the surface shall be rolled with a roller of if directed, it shall be stippled with a stippling brush.

Note:- All paints shall be of LOW VOC content as per Green Building Norms

POLISHING AND VARNISHING

French Polishing: (LOW VOC AS PER GREEN BUILDING NORMS)
French spirit polish shall be of an approved make conforming to IS:348. If it has to be prepared on site, the polish shall be made by dissolving 0.7 kg. of best shellac in 4.5 liters of methylated spirit without heating. To obtain required shade pigment may be added and mixed.

Surface shall be cleaned. All unevenness shall be rubbed down smooth with sand paper and well dusted. Knots, if visible, shall be covered with a preparation of red lead and glue. Resinous or loose knots and gaps shall be filled with season timber pieces and make level with rest of the surface. Holes and indentations on surface shall be filled with putty made of whiting and linseed oil. Surface shall be give a coat of filler made of 2.25 kg. of whiting in 1.5 liter of methylated spirit. When it dries, surface shall again be rubbed down perfectly smooth with sand paper and wiped clean.

Piece of clean fine cotton cloth and cotton wool made into shape of pad shall be used to apply polish. The pad shall be moistened with polish and rubbed hard on the surface applying the polish sparingly but uniformly and completely over the entire surface. It shall have allowed to dry and another coat applied in the same way. To give finishing coat, the pad shall be covered with a fresh piece of clean fine cotton cloth, slightly damped with methylated spirit and fubbed lightly and quickly with a circular motion, till the finish surface attains uniform texture and high gloss.

Wax Polishing: (LOW VOC AS PER GREEN BUILDING NORMS)

Wax polish shall either be prepared on site or obtained ready made from market. Polish made on the site shall be prepared from a mixture of pure bee's wax, linseed oil, turpentine oil and varnish in the ratio of 2:1.5:1:½ by weight. The bees wax and the boiled linseed oil shall be heated over a slow fire. When the wax is completely dissolved the mixture shall be cooled till it is just warm, and turpentine oil and varnish added to it in the required proportions and the entire mixture is well stirred.

Surface shall be prepared as described under French polishing except that the final rubbing shall be done with sand paper which has been slightly moistened with linseed oil.

Mixture or polish shall be applied evenly, with a clean cloth pad in such a way that no blank patches are left and rubbed continuously for half an hour. When the surface is quite dry a second coat shall be applied in the same manner and rubbed continuously for an hour or until the surface is dry. Final coat shall then be applied and rubbed for two hours or more if necessary, until the surface has assumed a uniform gloss and is quite dry showing no sign of sickness when touched. Gloss of the polish depends on the amount of rubbing, therefore rubbing must be continuous and with uniform pressure and frequent change in direction.

Varnishing : (LOW VOC AS PER GREEN BUILDING NORMS)

Surface shall be prepared as described above. After preparation of surface, two coats of clean boiled linseed oil shall be applied at sufficient interval of time. After the linseed oil has dried two coats of varnish obtained from approved manufacturer shall be applied at sufficient interval of time. If the surface fails to produce the required gloss an additional coat shall be applied without any extra cost.

GENERAL DEVELOPMENT AND ROAD WORK
EXCAVATION : As described previously
FILLING : As described previously
DRY RUBBLE PACKING : As described previously

Dry Rubble Pitching:
The pitching shall consist of large stones, regular in shape, as far as possible, and no stone shall be less than 20 cm. x 20 cm. on face and depth shall be s specified in the item. The edges of the stone shall be dressed even and regular by hammer and shall be laid regularly and evenly braking joint as much as possible and shall be beaten down with heavy hammer so as to be embedded into the earth. The interstices between the stones shall be carefully filled in with stone chips, closely and firmly packed and well driven with hammer. Loose stone in packing shall on no account be allowed. The entire

surface shall be thoroughly rammed, set in place and made compact with a log hammer so that the surface of entire pitching when completed shall be flat and even.

Water Bound Macadam:
6 cm. to 7.5 cm. size hand broken metal shall be spread over the prepared base to a thickness of 12 cm. The metal layer shall then be rolled and compacted by an 8 to 10-ton power roller. The thickness of the compacted layer after completing all the operations described below shall not be less than 7.5 cm.

Rolling shall start from edge of rod and proceed towards the crown in longitudinal strips overlapping on successive strips by at least one half the width of the rear wheel of the roller. the operation shall continue till no visible settlement of the metal or movement under the roller is observed. The gradient and camber shall be checked from time to time by means of level stakes, strings camber board etc. Any depression or hump shall be corrected by removing completely the metal layer there at and rolling the same satisfactorily till refusal.

After the dry rolling is completed either murum or stone dust, grit or sand shall be spread. Moderate sprinkling of water and rolling shall be continued and stone dust shall again be spread if required till all voids are completely filled and movement of metal under the wheel ceases. If there is excess powder the same shall be removed by light brooming. The surface shall be checked for camber etc. The unevenness or undulations shall be rectified as required. The whole surface shall be then watered and extra powder added if required, brushed and rolled to obtain mosaic surface. This surface shall be maintained till an upper layer is laid.

The rate of spreading either hard core or earth shall not be less than 0.3 cum. to 0.35 cum. per 10 sqm. area. The first layer of either murum / stone / grit / sand shall not be spread over a wet or watered metal layer.

FULL – GROUT
Spreading of Metal:
2.5 cm. to 4 cm. size stone metal shall be spread to a loose thickness of 10 cm. And compacted to a thickness of about 7.5 cm. by 8-ton power roller.

Applied Bitumen:
Bitumen 30/40 penetration of approved manufacturer, heated to a temperature of 200 C. (400 F) shall be applied hot by means of a pressure distributor or hand spray at the rate of 65 kg. / 10 sqm.

Blinding the Surface:
Immediately following the application of bitumen and while it is still hot, key aggregate 12 mm. size shall be evenly spread at the rate of 0.2 cum. / 10 sqm. After spreading the aggregate, the whole area shall be thoroughly rolled with a six to eight-ton power roller. It is important that this rolling shall be done when the bitumen is still movement under the roller.

Protection of the Surface:
The surface shall be protected from all traffic.

SEMI – GROUT
Spreading of Metal:
2.5 cm. to 4 cm. size stone metal shall be spread to a loose thickness of 7.5 cm. thick and compacted to a thickness of about 5 cm. by 8-ton power roller.

Applied Bitumen:
Bitumen 30/40 penetration of approved manufacturer, heated to a temperature of 200 C. (400 F) shall be applied hot by means of a pressure distributor or hand spray at the rate of 25 kg. / 10 sqm.

Blinding the Surface :
As in Full–Grout.

Seal Coat (For Full Grout and Semi Grout Surface) :
The surface shall be brushed free of any loose blindage, taking care that the brushing is not so severe as to remove the blindage but of the voids into which it is set. The surface shall then be tested for depression, which shall be made up by painting with bitumen 30/40 penetration and blinding with aggregate of a size, equivalent to the depth of depression.

Application of Bitumen:
Bitumen 80/100 penetration of approved manufacturer, heated to a temperature of 177 to 190 C. (350 to 375 F) shall than be applied evenly to the road surface by means of a pressure distributor or hand-spray at the rate of 12.5 kg. / 10 sqm.

Blinding and Final Consolidation:
While the bitumen is still hot the surface shall be blinded evenly with stone aggregate of 6 mm. and down gauge size. The blindage shall be clean and not contain any dust and the rate of application shall be 0.1 cum. per 10 sqm.

After spreading of the blindage, the road shall be given a final rolling with a eight-ton power. Any soft or depressions detected at a later date shall be made up as directed by the Architect without any extra cost.

Premix Asphalt Carpet:
The rate shall include preparation of surface.

Preparation of Surface:
Clean the surface with wire brush and dust it with gunny bags. All pot holes, depressions and corrugations shall be made good and applying a tack coat of 80/100 penetration bitumen heated to 177 to 191 C. and the depressions made up with suitable size premix aggregate and consolidated by approved means. The surface shall then be painted with 80/100 penetration bitumen heated to 177 to 191 C. at the rate of 7.5 kgs. Per 10 sqm.

Preparation of Premix:
Premix shall be prepared as under:
2.5 cm. thick consolidated.

No	Item of Work	Per 100 Sft.	Per 1000 Sft.
1	Stone metal 2 cm. (3/4”)	5 Cft.	15.25 Cum.
2	Stone chips 10 mm. (3/8”)	3 Cft.	9 Cum.
3	Grit / sand (of desired grade and quality)	4 Cft.	12 Cum.
4	Asphalt 80/100 penetration from approved manufacturer heated to 177 C.	50 lbs.	2450 Kgs.
5	Solvent*	3 lbs.	150 Kgs.
6	Filler	Either clean lime stone powder or Hydrated lime in desired quantity	

4 cm. thick consolidated (to be done in 2 courses) Base Course (2.5 cm. Thick)

No	Item of Work	Per 100 Sft.	Per 1000 Sft.
1	Stone metal 2.5 cm. (1”)	8 Cft.	24.5 Cum.
2	Stone chips 12 mm. (1/2”)	4 Cft.	12 Cum.
3	Asphalt 60/70 penetration from approved manufacturer heated to 177 C.	36 lbs.	1760 Kgs.
4	Filler	As Above	

Wearing Course (1.5 cm. Thick)

No	Item of Work	Per 100 Sft.	Per 1000 Sft.
1	Stone metal 12 cm. (1/2”)	5 Cft.	15.25 Cum.
2	Stone metal 6 mm. (1/4”)	2 Cft.	6 Cum.
3	Asphalt 60/70 or 80/100 penetration from approved manufacturer heated to 177 C	22 lbs.	1075 Kgs.
4	Solvent*	1.5 Lbs.	65 Kgs
5	Filler	As Above	

The quantity of solvent may vary depending upon the local weather conditions. Use of solvent and its quantity shall be determined by the Architects before commencement of the work. Batches should be proportioned in accordance with the capacity of the mixer being used. Place clean stone metal and chips in the mixer. Add 2/3 of the batch of quantity of the hot asphalt at the designed temperature along with solvent and mix well. Add grit / sand and filler and continue mixing until the sand / grit is uniformly disturbed throughout the mix. The add remaining quantity of hot asphalt and continue mixing till the whole mix is uniform and homogenous. If desired, the sand / grit shall be heated before use. The mix shall then be carried to the place of deposition by means of wheel barrows.

The proportion suggested above should in the normal course give a dense mix. If necessary the proportions may be varied to obtain a dense mix, at the discretion of the Architects, at no extra cost.

Laying of Premix:
The mix shall be laid to a uniform thickness and to proper level, grade and camber and rolled with six to eight-ton power roller. The surface shall be checked for grade and camber during rolling and premix added and removed as required. The thickness shall be as specified after consolidation. When the base course is rolled the wearing, course is laid similarly and rolled to give a consolidated thickness as specified in the time.

Premixed Seal Coat:
After the premix carpet is laid the surface shall be sealed with premix grit prepared as described under wearing course above with a suitable cutback added. The premixed seal must be brushed in to fill the interstices, additional material being applied during rolling of found necessary. The quantity of premixed seal shall be approximately 0.15 cum. Per 10 cum. The surface shall be finally dusted with stone powder and rolled to give a smooth finish.

Road Concrete:
Specification for aggregate cement and concreting shall be as specified in the section under “Materials”.

Before concreting, the surface shall be checked for the given profile. Wooden forms equal to the depth road slab thickness shall be erected to correct line and level and held by stakes driven into the ground along the outside edge at suitable intervals and two stakes being placed at each joint. Forms should be supported, strengthened or braced, whenever necessary so that they are able to prevent deformation and resist deformation under pressure of concrete or impact of tamping or vibrating. Working faces of all forms shall be thoroughly cleaned and oiled before use and forms which are used more than once, shall be carefully examined and trued, if necessary, before re-use.

Sub-grade shall be properly moistened before any concrete is deposited on it; care being taken to see that there are no standing pools of water. It may be advisable to have the sub grade watered 12 to 24 hours in advance of placing concrete. Concrete shall be laid in alternate bays not exceeding 30 sqm.
Concrete shall be deposited on sub-grade for the entire width of the slab and shall be kept sufficiently above the level of forms so that when tamped, it becomes a dense mass.

I.R.C. fabric reinforcement, if specified, shall be placed in correct position before commencing concreting.

The concrete shall be brought to the specified contour by means of heavy screed or tamper handles weighing not less than 10 kgs. / Meter and not less than 7.5 cm. wide or surface vibrator if directed by the Architects. This screed or tamper may be steel. It shall be drawn with a saw in motion in combination with a series of lefts and drops. At transverse joint tamper shall be drawn not closer than one meter towards the joint and shall than be lifted and set down at the joint and drawn backwards away therefrom. Surplus concrete shall then be taken up with shovels and thrown ahead of the joint. Immediately after the screeding or tamping has been completed the surface shall be inspected for high and low spots and any needed correction made by adding or removing concrete. The entire surface shall then the floated with hand floats one meter long and 7.5 cm. wide and this operation must be performed from bridge provided across the slab. The surface shall be roughened by brooming.

The longitudinal and transverse edges of the slab shall be properly formed with suitable tolls and the same should be rounded to 10 mm. radius.

The finished surface of the slab must conform to the grade, alignment and contours as directed and cured for fourteen days.

After curing period is over the joints shall be filled up with approved bitumastic filler. Unless otherwise specified, the rate shall include filling of joints as specified.

STORM WATER DRAINAGE
The work shall be carried out in accordance with rules and regulations of local Drainage Authority. Necessary provision for sight rails, boning staves etc. shall be made.

Tests regarding watertightness of joint and cleanliness of pipes shall be performed before the trenches are covered.

Work of laying pipe lines and provided Manholes, Chambers, etc., shall include necessary excavation in any strata including old foundations of any description, refilling the trenches in layers of 20 cm. watering and consolidation.

Pipes:
All Hume pipes (Reinforced) shall conform to the relevant I.S.S. and shall be new, perfectly sound, free from cracks, cylindrical, straight and of specified nominal diameter. They shall be made of reinforced cement concrete manufactured by centrifugal or spun process and shall have even texture.

Trenches:
The trenches for laying shall be excavated to lines and levels as directed. The bed of the

trench shall be truly and evenly dressed throughout from one change of grade to the next.

The gradient is to be set out by means of boning roads and should the required depth be exceeded at any point; the trench shall be brought to proper grade by means of cement or lime concrete of the specification of the bed concrete without any extra cost.

The bed of the trench, if in soft or made-up earth, shall be well watered and rammed and depressions thus formed filled with sand or other suitable materials as directed by the Architects.

If rock is met with, it will be removed to 15 cm. below the level of the pipe and the trench will be refilled with bed concrete, sand or other suitable material approved by the Architects.

The trench shall be kept free from water. Shoring and timbering shall be provided wherever required.

The width of trench shall be nominal diameter of the pipe plus 38 cm. but it shall not be less than 52 cm.

Laying of Pipes:
No concreting is ordinarily necessary. In cases where the soil is made up is very soft, concreting may be resorted to form the bed of the trench below the pipe, if directed by the Architects at no extra cost.

The pipes shall be carefully lid to levels and gradients shown in the plans and sections. Great care shall be taken to prevent sand etc., from entering the pipes. The pipes between two manholes shall be laid truly in straight lines without vertical or horizontal undulations. The body of the pipe shall for its entire length on an even bed in the trench and places shall be excavated to receive the collar for the purpose of jointing.

Jointing:
A few skeins of spun soaked in neat cement wash shall be inserted in the groove at the end of the pipe and the two adjoining pipes butted against each other. The collar shall then be slipped over the joint, covering equally both the pipes. Spun yarn soaked in neat cement wash shall be passed round the pipes and inserted in the joint by means of caulking tolls from ends of the collar. More skeins of yearn shall be added and well rammed above.

The object of the yarn is to center the two ends of the pipes within the collar and to prevent the cement mortar of the joint penetrating into the pipes.

Cement mortar with one part of cement and one part of sand shall be slightly moistened and must on no account be soft or sloppy and shall be carefully inserted by hand in to the joint and more cement mortar added until the space of the joint has been filled completely with tightly caulked mortar. The joint shall be finished off neatly outside the collar on both sides at an angle of 45.

Any surplus mortar projecting inside the joint is to be removed and to guard against any such projections sack or gunny bag shall be drawn past each joint after completion. Cement mortar joint shall be cured at least for seven days.

Testing:
All joints shall be tested to a head of 60 cm. of water above the top of the highest pipe between two manholes.

The lowest end of the pipe shall be plugged watertight. Water shall then be filled in manhole at the upper end of the line.

The depth of water in the manhole shall be 60 cm. plus the diameter of the pipe. The joint shall then be examined. Any joint found leaking or sweating shall be remade and embedded into 15 cm. layer of cement concrete (1:2:4) 30 cm. in length and the joint retested without any extra cost.

Manholes:
Size of manholes shall be s specified in the item and the sizes specified shall be internal size of the manhole. The work shall be done strictly as per standard drawing and specifications.

Bed Concrete:
Shall be in 1:4:8 cement concrete 23 cm. (9”) thick.

Brick Work:
Shall be with best quality local bricks and proportion of mortar shall be 1:4 unless otherwise specified.

Plaster:
Inside of the walls shall be plastered with 12 mm. thick cement plaster 1:3 and finished with floating coat of neat cement. The external face shall be pointed with 1:3 cement mortar.

Benching:
Channels and benching shall be done in cement concrete 1:2:4 rendered smooth with neat cement.

Foot Rests:
M.S. square rods of 22 mm. (7/8”) diameter or C.I. rungs shall be embedded in masonry where the depth of manhole exceeds one meter and they shall be fixed 35 cm. apart and projecting 11 cm. from the wall. Foot rests shall be painted with bitumen as directed.

Manhole Covers:
Covers for manhole in the road proper shall not be less than 200 kgs. on footpaths and backyards. Lightweight covers shall be used whose weight for 45 cm. dia. shall not be less than 58 kgs. and that of 90 cm. x 45 cm. or 61 cm. x 45 cm. 90 kgs.

Drop Connection:
The case of drop connection C.I. pipes shall be provided with heel rest bend at the bottom and bend with access door at the top for cleaning purposes. The pipe shall be encased in 1:3:6 plain concrete.

Miscellaneous Items of Work:
The rates quoted by the Contractor for all miscellaneous items of work viz. Cooking platforms, mories, built-in cupboards, counters, partitions, railings, electrical meter, switchboard cupboards, etc., shall be for the work as described in the schedule of quantities and as show in detailed drawings and shall be to the entire satisfaction of the Architects.

Doors and Windows

Functional Need of WINDOW

1. Windows should be fabricated with “Fusion welded corners”. The Mullion /Transom can be either Fusion welded or mechanically joined with desired sealing.

2. Windows / doors must conform to the strength requirements based on wind load as per IS 875-3.

3. Appropriate thickness of steel reinforcement should be selected to meet the desired strength. The reinforcement must be installed within 6 to 50mm distance from the face of the weld.

4. For window size ≤ 1500mm tolerance is ± 3.0mm and sizes above ≥ 1500 mm tolerances ± 5.0mm on both height and width.

5.The window diagonal should be less than equal to 5mm for window up to 1500mm, above 1500mm, the diagonal difference should not be more than 10mm

6. The minimum overlap of sashes on Frame/ mullion should be 5mm, higher overlap is desirable.

7. Water drainage / ventilation slot should be provided in sash / frames as described in section 9 of relevant IS standard

8. Min Gap of 3mm should be maintained per face between aperture and window to allow expansion / contraction of uPVC windows

9. The gap between window and its aperture should be filled with weatherable & elastic material to allow expansion / contraction of PVC and performance over period of years.

10. Material Description: The Windows shall be manufactured using Rigid uPVC profile sections, using GI reinforcement.

11. Fabrication Description: uPVC Window, size as per drawing of wall thickness 1.2mm ± 0.25mm made out of extruded section plain uPVC sections.

12. The window frame made out of rigid uPVC sections meter cut at 4 corners & joint with plastic fusion welding with internal reinforce required.

13. The shutter section made out of extruded rigid uPVC with internal reinforced with provision of 5mm glaze/wire mesh as per requirement.

14. The window shall be fixed to the wall using 65x100mm long M.S. fasteners at suitable place provided for each vertical and horizontal member etc. complete as per manufacture’s specification and direction of Engineer-in-charge.

15. All the surface of Window should be uniform smooth finish and free from crack and seam. Passing joints shall be finished ensuring that no gaps are visible.

16. Tolerance: All Dimensions (except thickness of profile sections) shall be as per drawing 1.2mm thickness should be in ± 0.25mm.

17. Measurement: The unit of measurement shall be in square meter or square feet.

18. Payment: Price shall be covering the fabrication, handling and installation including labor, material and equipment. Manufacture should provide maintenance manual and basic material test report for certification.

Technical Specifications For Fixed Furniture

SCOPE OF WORK: The work covered in this specification include providing, fixing and furnishing the Wardrobes, Overhead cabinets at given locations, as glass panes / wooden to teak wood or ply doors, strictly in accordance with the specifications and

detailed drawings. Wardrobes, cabinets, etc. shall be fabricated and assembled in the workshop as far as practicable and then brought inside the building ready to set in place. The various members shall be worked in the best manner known to the trade, mortised and tenured, doweled, blocked and glued together so as to avoid the use of nails as far as possible. The details shall be closely followed, molding clearly cut and miters accurately made. Free edge of shutters, shelves, partitions, sides etc. shall be provided with first class rubber wood edging, glued and nailed in approved manner.

Preservative treatment: All wood work in contract with masonry shall be painted with approved asphalt or anti termite & fire-retardant coating before placing. Care shall be taken to keep exposed surfaces clear from tar etc. Felt shall be used to isolated wood from masonry wherever practicable. All concealed wood etc. shall be treated fully and liberally with lignum before placing in position.

Painting and Polishing: All exposed teak faces of partitions, glazing, doors, cabinet work etc. shall be painted / polished to approve finish. Door shutters, internal faces of cupboards and cabinets etc. shall be enamel painted to approve finish. All the paints & polishes should be of LOW VOC content as per Green building norms.

Protection of work: The contractor shall be responsible for the temporary doors and closing in opening necessary for the protection of the work during progress. He shall also provide and maintain any other temporary.

General Requirements:

1. All teak wood shall be of medium seasoned teak, free from sap, knots, cracks and shall be of lighter grains and shall be of approved range. If required, teak wood shall be tested in laboratories at Contractors expenditure. All Sal wood shall be seasoned, free from sap, knots and cracks and as per approved sample.

2. All teak wood, plywood's and any other wood used in the work shall be coated with approved quality anti-termite i.e. Touch wood or approved equivalent type. At site with a test certificate at contractors expenditure.

3. All door shutters shall be fitted with approved fittings.

4. All screws shall be machine made and of approved equivalent make.

5. Even if it is not mentioned in the specifications / drawings, it should be clearly understood that all open edges of fitted plywood (i.e. door, cupboard, shutter, drawers etc.) shall be provided with teak wood beadings. All teak wood beadings shall match laminate shade or in approved finish.

6. The rate quoted in all the items shall include the cost of all fixtures, materials, manufacturing, transportation, installation, sales tax and other taxes if any etc. All partitions / paneling shall have provisions for conducts of electricity/ telephone/ computer / audio- visual / Fire alarm / Intercom etc.

7. No work shall be executed at the site without prior approval of samples of all parts.

Note : Regarding the availability of the material and that only materials called for under preference shall be supplied and installed. In the event of the materials of make called for are not available and alternative makes are approved for incorporation in the work, the rates quoted shall be suitable amended bases on the price variation between the specified marks and alternative makes on the day the alternative makes are accepted.

Material :
The material shall conform to IS:2095.

 Plywood /Plywood Boards : Plywood boards are formed by gluing and pressing three or more layers of veneers with the grains of adjacent veneers running at right angles to each other. The veneers shall be either rotary cut or sliced and shall be

sufficiently smooth to permit an even spread of glue. Face veneers may be either decorative on both sides or one side commercial and the other decorative. Plywood shall be of BWP grade.

 Adhesive: Adhesive used for bonding BWP grade of plywood boards shall be BWP type synthetic resins conforming to IS 848 .

 Thickness: Plywood boards shall be as mentioned in the specified item / detailed drawings. Tolerance in thickness shall be ± 10% for boards up to and including 5 mm; ± 7% for boards from 6 to 9 mm and ± 5% for boards above 9 mm thickness. The boards shall be of uniform thickness and the surfaces of the boards shall be sanded to a smooth finish. Number of plies in plywood boards shall be as per the drawings.

 Moisture content of the plywood boards when tested in accordance with IS 1734 (Part 1) shall not be less than 5 per cent and not more than 15 per cent.

 Testing: One sample for every 100 sqm or part thereof shall be taken and testing done as per IS 303. However, testing may not be done if the total requirement of plywood boards is less than 30 sqm. All the samples tested shall meet the requirements of physical and mechanical properties of plywood boards

 Particle Boards: Particle boards shall be of medium density and manufactured from particles of agro waste, wood or lignocelluloses i.e. material blended with adhesive and formed into solid panels under the influence of heat, moisture, pressure etc. The particle boards shall be flat pressed three layered or graded and of Grade-I as per Table 1 of IS 3087. Both surfaces of the boards shall be sanded to obtain a smooth finish and shall conform to IS 3087.

 Thickness and Tolerance: Thickness of particle boards shall be as specified. Tolerance in thickness shall be ± 5% for boards up to and including 25 mm thick and ± 2.5 per cent for boards above 25 mm thickness. Each board shall be of uniform thickness.

Testing: One sample for every 100 sqm or part thereof shall be taken and testing done as per IS 3087. However, testing may not be done if the total requirement of particle boards in a work is less than 30 sqm. All the samples tested shall meet the requirement of physical and mechanical properties of particle boards specified.

BLOCK BOARD:

Block boards have a solid core made up of uniform strip of wood each not exceeding 25mm in width, laid separately, or spot glued, or otherwise joined to form a slab which is glued. Between two or more outer veneers, with the direction of the grain of the core block running at right angles to that of adjacent veneers, in any one block board, the core strips shall be of one species of timber only. Face veneers may be decorative on one face and commercial on the other, Block boards shall be Grade I (Exterior Grade) as per IS : 1659.Both surfaces of the boards shall be sanded to a smooth finish.

Adhesives: the adhesives used for bonding shall be BWP type synthetic resin confirming to IS:848 for Grade I block boards.

Thickness and Tolerance: Block boards are available in thickness ranging from 12 to 50 mm. Tolerance in thickness shall be +5% for boards up to and including 25 mm thickness. Each board shall be of uniform thickness.

Testing: One sample for every 100 sqm or part thereof shall be taken and testing done as per IS: 1659. However, testing may not be done if the total requirement of block boards is less than 30 sqm. All the samples tested must meet the requirements of physical and mechanical properties of block boards specified in the relevant B.I.S. code Type of face veneers, thickness and grade of block boards shall be specified unless otherwise stated, grade I (exterior grade) block board bonded with BWP grade be used.

Laying

 Panels are stored in a dry place and water should not come in contact with panels during or after construction. If the panels get wet, they should be dried before use.

 The floor should be perfectly level before laying the first course. All panels must be properly aligned to the plumb. Successive layer of panels must be alternatively staggered so that vertical joints are not in the same line.

 The recommended quantity of Gypsum Bonding Plaster must be used for joints and filling the grooves made for conduits, pipelines, etc. Excess Bonding Plaster must be scooped and removed, so that the joints and the places where the grooves are filled in are flush and even.

 The walls should be dry and sanding done properly especially at joints before the primer is applied so that the surface is even and joints will not be visible after painting. Avoid chasing with chisel and hammer. Use electrical saw or grooving tools for conduiting etc.

 The recommended span of walls is maximum 6 meters and maximum height is 4.5 meters

 Gypsum panel can easily be cut with coarse tooth hand saw, electric jigsaw, etc. The panels can be cut, sawn, drilled, milled or dowelled on the job. For concealed piping and conduit, the depth of groove should not exceed 50 mm. Hammer and chisel techniques to form chases must be avoided.

Sanding: This application is to make the surface level without undulations. To make the gypsum wall surface level (in particular at joints, where there is excess bonding plaster), do sanding with sand paper at joints and other places, wherever you find uneven surface, otherwise joints will be visible after painting. It is important to sand all joints uniformly.
Primer Application: The purpose of the primer is to give a better adhesion to the paint and also to reduce consumption of paint on the wall. Water thinable (Low VOC) primers shall be used only.

WBP Glue Line -- BS 1088 plywood must use an adhesive, which has been proven to be highly resistant to weather, micro-organisms, cold and boiling water, steam and dry heat. The product's bonding must pass a series of BS tests. Face Veneers -- These must present a solid surface that is free from open defects.

Face veneers-- must be free of knots other than "sound pin" knots, of which there shall be no more than six(6) in any area of one(1) square foot, and there can be no more than an average of two(2) such knots per square foot area over the entire surface of the plywood sheet. The veneers must be reasonably free from irregular grain. The use of edge joints is limited, and end joints are not allowed.

Core Veneers -- Core veneers have the same basic requirements as face veneers, except that small splits are allowed, and there is no limit on the number of pin knots or edge joints. However, end joints are not permitted.

Limits of Manufacturing Defects -- Defective bonds, pleats and overlaps, and gaps in faces are not permitted. Occasional gaps may be repaired using veneer inserts bonded with the proper adhesive.

Moisture Content -- BS 1088 plywood must have moisture content between 6% and 14% when it leaves the factory.

Length & Width -- The length or width of a board produced as a standard size shall not be less than the specified size nor more than 6.3 mm (0.25") greater than the specified size. The lengths of the diagonals of a board shall not differ by more than 0.25% of the length of the diagonal.

MATERIAL TEST LIST

The Contractors will have to take necessary material test as per I.S. code, which is applicable, at their own cost for the following materials or any other material using in construction work periodically or as and when required by the Architects / Consulting Engineer.

The materials should be got tested in an approved Laboratory as per IS standard and test reports in duplicate should be submitted to the Architect's Office.

Sr. No	**Material**	**Tests to be Carried out**
1	Sand	a) Silt Content.
		b) Bulking.
		c) Particle size distribution.
		d) Or as directed.
2	Stone Aggregates	a) Soft and deleterious Material
		b) Particle Size Distribution
3	Cement Concrete RCC Mix Design	a) Slump
		b) Cube Strength
		c) Or as per IS456-2000
4	Bricks/Blocks	a) Dimensions
		b) Water absorption and fluorescence.
		c) Compressive Strength
5	Timber	Moisture
6	Ceramic/Vitrified Floor Tiles	a) Transverse Test
		b) Water absorption
		c) Abrasion Test
7	Steel	a) Tensile Strength
		b) Ductility

Note: The Contractor will have to take necessary material test other than above test as per relevant I.S. code, if required and as directed by APMCF / SBI.

MATERIAL TESTING FREQUENCY CHART

A chart showing the recommended time and quantity scheduled for conducting test on various building materials is given. Please ensure that tests are carried our according to the above guidelines. Contractor's rate should include for necessary expenditure for testing including transport of samples of following tests.

Sr. No.	Material	Test.	Frequency of Testing	Remarks.
1.	Sand	i)Fineness Modulus. ii)Silt Content.	At the beginning & if there is change insource.	
2.	Masonry Stone.	i)Comp. strength. ii)Specific Gravity. iii)Water Absorption.	A set of 5 stones for each quarry & fordoubtful quality.	
3.	Metal.	i)Crushing Value. ii)Impact Value. iii)Abrasion value. iv)Water Absorption. v)Flakiness Index. vi)Stripping value. vii)Gradation.	One test per 200 cum or part thereof.	I.S. 2386Part-II.
4.	Bricks.	i)Crushing Strength. ii)Water Absorption.	A set of 15 Bricks for each 50,000 consignments or part thereof.	I.S.1077
5.	Flooring Tiles.	i)Flexural strength. ii)Water Absorption.	A set of 12 Tiles for each 2,000 Tiles orpart thereof.	I.S.1237-1989.
6.	Glazed Tiles	Water Absorption.	A set of 16 Tiles for each 2000 Tiles or part thereof.	IS 13630 (Parts 1 to 15) : 2006
7.	Design Mix	For Every Grade of Concrete	Initially and on every source change of materials	IS-456 & MORTH 1700 Structural Concrete

Sr. No.	Material	Test.	Frequency of Testing	Remarks.
8.	Cement Concrete.	i) Slump ii) Cube/Compressive Strength	For Each Batch Up to 5 cum. 1set. 6-15 cum- 2 sets. 16-30 cum- 3 sets. 31-50 cum- 4 sets. 51 & above-4sets + 1 additional set foreach additional 50 cum or part thereof.	IS 456
9.	Cement.	i) Comp. strength. ii) Initial setting time.) Final setting time.) Specific Gravity. v) Soundness. vi) Fineness.	One test for each consignment of 50 M.T. (1000 bags) or part thereof.	I.S.269-12269.
10.	Steel.	i) Wt. per meter. ii) Ultimate Tensile stress. iii) Yield stress. iv) Elongation. v) Chemical Test	As Specified in clause no 64 of Special Conditions of Contract.	I.S.432.
11.	AAC Block	i) Density Test ii) Compressive Strength. Thermal Conductivity Drying Shrinkage	Every lot of 10000 Nos Every lot of 10000 Nos Every lot of 10000 Nos Every lot of 10000 Nos	IS 6441 (Part-I) & IS : 2185 (Part 3 j -1984
12.	Paving Block	i)Compressive Strength ii)Water Absorption	Every lot Every lot	IS 15658 : 2021
13.	Aluminum Section	i) Thickness, Mass Per Running meter ii) Test on Powder Coating	Test to be carried as per IS codes & Instructions of Engineer In-charge.	IS: 1081-1960 IS 1949 (1961) IS 1948:1961

Note : The Contractor will have to take necessary material test other than above test as per I.S. code for above material or other than above material, if required and as directed by the APMCF / SBI.

The contractor shall install testing equipment as per requirement on site. The contractor shall ensure and certify the calibration of the equipment so installed and shall maintain the same in working order throughout the period of construction.

The contractor shall also provide the necessary trained staff for carrying out such tests for using such equipment.

The tests shall be carried out under the supervision of the Engineer-in-charge. 70% of the total tests to be done is to be carried out on site laboratory if the facilities are available as per tender terms and conditions, remaining 15% tests is to be carried out at govt./ Semi Govt. laboratory and 15% tests is to be carried out at Govt. recognized/NABL accredited laboratory.

THEORETICAL CEMENT CONSUMPTION STATEMENT (BASE CPWD)

No	Description of item of work.	Quantity of cement to be used per Unit Quantity of work.	Unit.
1	Cement Concrete (Cast in Situ) Plain or Reinforced.		
a.	1:1:2 (1 Cement: 1 Sand :2 Graded Aggregate).	12.20 Bags.	Cubic Meter
b.	1:1.5:3(1 Cement:1.5 sand:3 Graded Aggregate).	8.00 Bags.	Cubic Meter
c.	1:2:4 (1 Cement: 2 Sand :4 Graded Aggregate).	6.40 Bags.	Cubic Meter
d.	1:3:6 (1 Cement: 3 Sand :6 Graded Aggregate).	4.40 Bags.	Cubic Meter
e.	1:4:8 (1 Cement: 4 Sand :8 Graded Aggregate).	3.40 Bags.	Cubic Meter
f.	1:5:10(1 Cement: 5 Sand :10 Graded Aggregate).	2.60 Bags.	Cubic Meter
g.	Providing and laying cement concrete 1:2:4 (1 Cement: 2 Coarse Sand: 4 Graded Aggregate of 20 mm. nominal size) including finishing exposed surface with 6 mm. thick cement mortar 1:3 (1 Cement: 3 Fine Sand). Krebs, Steps, and the like.	7.02 Bags.	Cubic Meter
h.	String or lacing courses, parapets, coping, bed blocks, anchor blocks, plain window sills and the like moldings in cornices, window sills etc.	7.62 Bags.	Cubic Meter
1.1	Ready Mix/Design mix Concrete		
	M20 & Above Grades	As per Approved Design Mix /RMC Batch Report	As per Approved Design Mix /RMC Batch Report
2.	Cement Mortar		
a.	1:1 (1Cement: 1 Sand)	20.40 Bags.	Cubic Meter
b.	1:2 (1Cement: 2 Sand)	13.60 Bags.	Cubic Meter
c.	1:3 (1Cement: 3 Sand)	10.20 Bags.	Cubic Meter
d.	1:4 (1Cement: 4 Sand)	7.60 Bags.	Cubic Meter
e.	1:5 (1Cement: 5 Sand)	6.20 Bags.	Cubic Meter
f.	1:6 (1Cement: 6 Sand)	5.00 Bags.	Cubic Meter
g.	1:2 (1Cement: 2 Stone Dust)	13.60 Bags.	Cubic Meter
h.	1:2 (1Cement: 2 Marble Dust)	13.60 Bags.	Cubic Meter
i.	1:5 (1Cement: 5 Marble Dust)	6.20 Bags.	Cubic Meter
j.	1:1:3 (1Cement: 1 Marble Dust: 3 Stone Dust)	7.60 Bags.	Cubic Meter
k.	White Cement Mortar 1:2 (1 White Cement: 2 Marble Dust)	13.60 Bags.	Cubic Meter
l.	White Cement Mortar 1:3 (1 White Cement: 3 Marble Dust)	10.20 Bags.	Cubic Meter
m.	White Cement Mortar 1:5 (1 White Cement: 5 Marble Dust)	6.20 Bags.	Cubic Meter
3.	Cement Lime Mortar		
a.	1:1:3 (1 Cement:1 Lime putty:3	8.20 Bags.	Cubic Meter

	Sand)		
b.	1:1:6 (1 Cement:1 Lime putty:6 Sand)	5.00 Bags.	Cubic Meter
4.	Brick Work in All Classes		
a.	In Cement Mortar 1:3 (1 Cement:3 Sand)	2.56 Bags.	Cubic Meter
b.	In Cement Mortar 1:4 (1 Cement:4 Sand)	1.90 Bags.	Cubic Meter
c.	In Cement Mortar 1:5 (1 Cement:5 Sand)	1.56 Bags.	Cubic Meter
d.	In Cement Mortar 1:6 (1 Cement:6 Sand)	1.24 Bags.	Cubic Meter
5.	Half Brick Work in All Classes		
a.	In Cement Mortar 1:3 (1 Cement:3 Sand) With or without hoop iron.	28.56 Bags per 100 Square Meter	
b.	In Cement Mortar 1:4 (1 Cement:4 Sand)	21.28 Bags per 100 Square Meter	
c.	In Cement Mortar 1:5 (1 Cement:5 Sand)	14.50 Bags per 100 Square Meter	
d.	Molding and cornices in brick masonry in cement mortar 1:4 Cement:4 Sand) Joining old brick work with new brick work.	0.18 Bags per 100 Square Meter per cm. Girth	
	a) Old Brick in metric or FPS. System with new brick work in metric system in cement mortar 1:4 (1 Cement: 4 Sand).	4.20 Bags per 100 Square Meter	
	b) Old Brick work in FPS. System with new brick work in cement mortar 1:4 (1 Cement: 4 Sand).	5.44 Bags per 100 Square Meter	
6.	Random Rubble Masonry		
a.	Cement Mortar 1:6 (1 Cement: 6 Sand)	1.70 Bags.	Cubic Meter
b.	Cement Lime Mortar 1:1:8 (1 Cement: 1 Lime Putty: 8 Sand)	1.32 Bags.	Cubic Meter
7.	Coursed Rubble Masonry		
a.	Cement Mortar 1:6 (1 Cement: 6 Sand)	1.50 Bags.	Cubic Meter
8.	Ashlar Masonry In plain ashlar punched (ordinary) in superstructure in cement mortar 1:6 (1 Cement: 6 Sand) including pointing with cement mortar 1:2 (1Cement:6 Stone dust) with an admixture of pigment matching the stone shade.	1.08 Bags.	Cubic Meter
9.	Stone Veneering Work For wall lining etc., average thickness 40 mm. to 170 mm. in cement lime mortar 1:1:6 (1Cement:1 Lime Putty:6 Sand) including pointing in White cement mortar 1:2 (1 White Cement: 2 Stone Dust) with an admixture of pigment matching the stone shade.	17.50 Bags per 100 Square Meter	
10.	Marble work in steps jambs, walls, pillars and other plain work in cement mortar 1:4 (1 Cement: 4 Sand) including pointing in White cement mortar 1:2 (1 Cement: 2 Marble dust).	0.136 Bags per 1.52 Bags per	Cubic Meter (Grey Cement) Cubic Meter (White Cement)

11.	Marble work in steps jambs, walls, pillars and other plain work in cement mortar 1:4 (1 Cement: 4 Sand) including pointing in cement mortar (1 Cement : 2 Marble dust).	1.66 Bags per	Cubic Meter
12.	Marble work for wall lining (Veneer) work) 2.5 cm. thick in cement mortar 1:3 (1 Cement : 3 Sand) including pointing in White cement mortar 1:2 (1 Cement : 2 Marble dust).	1.1. Bags per 100 Square Meter (Grey Cement) a. Bags per 100 Square Meter (White Cement)	
13.	Marble work for wall lining (Veneer) work) 2.5 cm. thick in cement mortar 1:3 (1 Cement : 3 Sand) including pointing in cement mortar 1:2 (1 Cement : 2 Marble dust).	17.68 Bags per	Square Meter
14.	Marble work for wall lining (Veneer) work) 4 cm. thick in cement mortar 1:3 (1 Cement : 3 Sand) including pointing in White cement mortar 1:2 (1 Cement : 2 Marble dust).	20.40 Bags per 100 Square Meter. (Grey Cement) 1.1. Bags per 100 Square Meter (White Cement)	
15.	Marble work for wall lining (Veneer) work) 4 cm. thick in cement mortar 1:3 (1 Cement : 3 Sand) including pointing in cement mortar 1:2 (1 Cement : 2 Marble dust).	23.80 Bags per 100 Square Meter.	
16.	Cement Concrete Flooring Flooring 1:2:4 (1 Cement: 2 Sand : 4 Graded Stone Aggregate) finished with a floating coat of neat cement including cement slurry rounding of edges and strips etc., but excluding cost of nosing of steps etc., complete.		
a.	25 mm. thick with 20 mm. nominal size stone aggregate.	0.244 Bags	Square Meter
b.	40 mm. thick with 20 mm. nominal size stone aggregate.	0.34 Bags	Square Meter
c.	50 mm. thick with 20 mm. nominal size stone aggregate.	0.404 Bags	Square Meter
d.	75 mm. thick with 20 mm. nominal size stone aggregate.	0.564 Bags	Square Meter
17.	Cement Plaster Skirting (up to 30 cm. height) with cement mortar 1:3 (1 Cement: 3 Coarse Sand) finished with a floating coat of neat cement including rounding of junctions with floor, including slurry complete.		
a.	18 mm. thick.	0.32 Bags	Square Meter
b.	21 mm. thick.	0.35 Bags	Square Meter
18.	Pavement (25 to 50 mm. thick) with 1:2:4 (1 Cement: 2 Coarse Sand : 4 Graded Stone Aggregate 20 mm. nominal size) including finishing complete.	6.80 Bags	Cubic Meter
19.	Terrazzo Flooring 40 mm. thick marble chips flooring rubbed and polished to granolithic finish, under layer 34 mm. thick		

	cement concrete 1:2:4 (1 Cement: 2 Coarse Sand: 4 Graded Stone Aggregate 12.5 mm. nominal size) and top layer 6 mm. thick with white, black or white and black marble chips of size 1 mm. to 4 mm. nominal size laid in cement marble powder 3:1 mix. (3 Cement: 1 Marble Powder) by weight in proportion of 4:7 (4 Cement marble powder) by weight in marble powder mix:7 Marble chips) by volume including cement slurry etc., complete.		
a.	Dark shade / Light shade pigment with ordinary cement.	0.339 Bags per	Square Meter
b.	Light shade pigment with white cement.	0.258 Bags per 0.081 Bags per	Square Meter (Grey Cement) (White Cement)
c.	Medium shade pigment with approximately 50% white cement and 50% ordinary cement.	0.298 Bags Per 0.0440 Bags per	Square Meter (Grey Cement) (White Cement)
20	40 mm. thick marble chips flooring rubbed and polished to granolithic finish, under layer 31 mm. thick cement concrete 1:2:4 (1 Cement: 2 Coarse Sand: 4 Graded Stone Aggregate 12.5 mm. nominal size) and top layer 9 mm. thick marble chips, chips, size 4 to 7 mm. size, laid in cement marble powder mix. 3:1) (3 Cement : 1 Marble Powder) by volume in proportion of 4:7 (4 Cement marble powder mix. 7 Marble chips) by volume including cement slurry etc., complete.		
a.	Dark shade / Light shade pigment with ordinary cement.	0.357 Bags	Square Meter
b.	Light shade pigment with white cement.	0.241 Bags 0.116 Bags	Square Meter (Grey Cement) Square Meter (White Cement)
c.	Medium shade pigment with approximately 50% white cement and 50% ordinary cement.	0.299 Bags 0.058 Bags	Square Meter (Grey Cement) Square Meter (White Cement)
21	40 mm. thick marble chips flooring rubbed and polished to granolithic finish, under layer 28 mm. thick cement concrete 1:2:4 (1 Cement: 2 Coarse Sand: 4 Graded Stone Aggregate 12.5 mm. nominal size) and top layer 9 mm. thick marble chips, chips, sizes 7 mm to 10 mm. nominal size, laid in cement marble powder mix. 3:1) by weight in proportion of 2:3 (2 Cement Marble Powder mix. 3 Marble Chips) by volume including cement slurry etc., complete.		
a.	Dark or Light shade pigments with grey cement.	0.381 Bags	Square Meter
b.	Light shade pigment or without	0.219 Bags	Square Meter

	any pigment with white cement.	0.162 Bags	(Grey Cement) Square Meter (White Cement)
c.	Medium shade pigment with approximately 50% grey cement and 50% white cement.	0.300 Bags 0.081 Bags	S.M. (Grey Cement) S.M. (White Cement)
22	Marble chips skirting (up to 300 mm high) rubbed and polished to granolithic finish top layer 6 mm. thick marble chips of sizes from smallest to 4 mm. nominal size laid to cement marble powder mix. 3:1 (3 Cement: 1 Marble Powder mix. By weight in proportion of 4:7 (4 Cement Marble Powder mix: 7 marble chips) by volume including cement slurry complete.		
a.	18 mm. thick with under layer 12 mm. thick cement plaster 1:3 (1 Cement: 3 Coarse Sand) dark or light shade pigment with grey cement.	0.298 Bags	Square Meter
b.	Light shade pigment or no pigment with cement.	0.217 Bags Per Square Meter (Grey Cement) 0.081 Bags Per Square Meter (White Cement)	
c.	Medium shade colour pigment with 50% grey cement and 50% white cement.	0.258 Bags Per Square Meter (Grey Cement) 0.0406 Bags Per Square Meter (White Cement)	
d.	21 mm. thick with under layer 15 mm. thick cement plaster 1:3 (1 Cement: 3 Course Sand) dark or light shade pigment with grey cement.	0.327 Bags	Square Meter
e.	Light shade pigment or no pigment with white cement.	0.246 Bags Per Square Meter (Grey Cement) 0.081 Bags Per Square Meter (White Cement)	
f.	Medium shade pigment with 50% grey cement and 50% white cement.	0.286 Bags Per Square Meter (Grey Cement) 0.04 Bags Per Square Meter (White Cement)	
23.	Tile Flooring:		
a.	Precast terrazzo tiles 20 mm. thick white, black or white and black marble chips of size up to 6 mm. laid in floors treads of steps and landings jointed with neat cement slurry mixed with pigment to match the shade of the tile including rubbing polishing with precast tiles of 30 mm. thick bed of lime mortar 1:1.2 or 1:3 light shade using white cement.	0.088 Bags Per Square Meter (Grey Cement) 0.088 Bags Per Square Meter (White Cement)	
b.	Medium shade colour pigment with 50% white cement and 50% grey cement.	0.132 Bags Per Square Meter (Grey Cement) 0.044 Bags Per Square Meter (White Cement)	

c.	Dark shades using ordinary cement precast terrazzo tiles 20 mm. thick with marble chips of size 6 mm. in skirting and risers of steps not exceeding 30 cm. in height on wall, laid on 12 mm. thick cement plaster 1:3 mix. (1 Cement: 3 Sand) joint with neat cement slurry, light shades using white cement.	0.235 Bags Per Square Meter (Grey Cement) 0.044 Bags Per Square Meter (White Cement)
d.	Medium shade colour pigment with 50% white cement and 50% ordinary cement.	0.257 Bags Per Square Meter (Grey Cement) 0.022 Bags Per Square Meter (White Cement)
e.	Dark shades using ordinary cement.	0.279 Bags Square Meter
24.	Checkered Terrazzo Tile Flooring	
a.	Checkered Terrazzo Tile 22 mm. thick with marble chips of sizes up to 6 mm. in floors, jointed with neat cement slurry mixed with pigment to match the shade of the tiles including robbing, polishing complete on 28 mm. thick bed of lime mortar 1:1.2 or 1:3.	
a.	Light shade using white cement.	0.088 Bags Per Square Meter (Grey Cement) 0.096 Bags Per Square Meter (White Cement)
b.	Medium shades using 50% grey cement and 50% white cement.	0.136 Bags Per Square Meter (Grey Cement) 0.048 Bags Per Square Meter (White Cement)
c.	Dark shade using grey cement.	0.184 Bags Per Square Meter (Grey Cement)
d.	Checkered Terrazzo Tile 30 mm. thick with marble chips of sizes up to 6 mm. in stairs, treads, jointed with neat cement slurry mixed with pigment to match the shade of the tiles including rubbing polishing rounding of nosing etc., complete on 20 mm. bed of : Lime mortar 1:1:1 (1 Lime putty:1 Surkhi:1 Coarse Sand) :	
i.	Light shade using white cement.	0.088 Bags Per Square Meter (Grey Cement) 0.136 Bags Per Square Meter (White Cement)
ii.	Medium shades using 50% grey cement and 50% white cement.	0.154 Bags Per Square Meter (Grey Cement) 0.066 Bags Per Square Meter (White Cement)
iii.	Dark shade using grey cement.	0.220 Bags Per Square Meter (Grey Cement)
e.	Cement mortar1 :4 (1 Cement :4 Corse Sand)	
i.	Light shade using white cement.	0.258 Bags Per Square Meter (Grey Cement) 0.132 Bags Per Square Meter (White Cement)

ii.	Medium shades using 50% grey cement and 50% white cement.	0.324 Bags Per Square Meter (Grey Cement) 0.066 Bags Per Square Meter (White Cement)
iii.	Dark shade using grey cement.	0.39 Bags Square Meter (Grey Cement)
25.	White Glazed Tiles.	
	White Glazed Tiles 5,6 or 7 mm. thick in flooring treads risers of steps skirting and dado on 12 mm. thick cement plaster 1:3 (1 Cement: 3 sand) in base and cement joined with white cement slurry etc. complete.	0.188 Bags Per Square Meter (Grey Cement) 0.050 Bags Per Square Meter (White Cement)
26.	Marble Stone Flooring	
	Marble Stone slab flooring over 20 mm. thick base of lime mortar 1:1:1 (1 Lime putty:1 Surkhi:1 Sand) and jointed with grey cement slurry etc. (all marble slabs).	
a.	20 mm. thick	0.098 Bags Per Square Meter
b.	30 mm. thick	0.102 Bags Per Square Meter
c.	40 mm. thick	0.107 Bags Per Square Meter
	Marble stone slab flooring over 20 mm. thick base of cement mortar 1:4 (1 Cement:4 Sand) and jointed with grey cement slurry etc., (all marble slabs).	
d.	20 mm. thick	0.268 Bags Per Square Meter
e.	30 mm. thick	0.273 Bags Per Square Meter
f.	40 mm. thick	0.277 Bags Per Square Meter
g.	Extra if white cement slurry is used instead of grey cement slurry in joints of marble stone flooring.	0.015 Bags Per Square Meter (White Cement)
h.	Marble slabs 30 mm. thick in risers of steps, skirting dado, wall and pillars, laid on 12 mm. thick cement mortar 1:3 (1 Cement : 3 Sand) and jointed with grey cement slurry.	0.246 Bags Per Square Meter (White Cement)
27.	Kotah Stone Flooring	
	Kotah stone slab flooring over 20 mm. thick base of lime mortar 1:1:1 (1 Lime putty:1 Surkhi:1 Sand) and jointed with neat cement slurry etc.	
a.	25 mm. thick	0.128 Bags Per Square Meter
b.	30 mm. thick	0.136 Bags Per Square Meter
c.	40 mm. thick	0.152 Bags Per Square Meter
	Kotah Stone slab flooring over 20 mm. thick base of cement mortar 1:4 (1 Cement:4 Sand) and jointed with neat cement slurry etc.	
d.	25 mm. thick	0.298 Bags Per Square Meter
e.	30 mm. thick	0.306 Bags Per Square Meter
f.	40 mm. thick	0.322 Bags Per Square Meter
g.	Kotah stone slab 25 mm. thick risers of steps, skirting, dado and pillar laid on 12 mm. thick cement mortar 1:3 (1 Cement:3 Sand) and jointed with neat cement slurry etc.	0.275 Bags Per Square Meter
28	Sandstone Flooring	

a.	40 mm. thick sandstone flooring over 20 mm. thick base of cement mortar 1:5 (1 Cement :5 Sand) with joints finish flush.	0.155 Bags Per Square Meter
b.	40 mm. thick sand stone flooring over 20 mm. thick base of cement mortar 1:5 (1 Cement :5 Sand) including pointing with cement mortar 1:2 (1 Cement: 2 Stone Dust).	0.186 Bags Per Square Meter
c.	40 mm. thick sandstone flooring over 20 mm. thick base of lime mortar 1:1:1 (1 Lime :1 Surkhi:1 Sand) including pointing with cement plaster 1:2 (1 Cement :2 Stone Dust).	0.031 Bags Per Square Meter
d.	40 mm. thick fine dressed and rubbed stone flooring over 20 mm. thick base of cement mortar 1:5 (1 Cement :5 Sand) with joints 5 mm. thick finished flush.	0.166 Bags Per Square Meter
e.	40 mm. thick fine dressed and rubbed stone flooring over 20 mm. thick base of lime mortar 1:5 (1 Cement : 5 Sand) with joints 5 mm. thick including pointing with cement mortar 1:2 (1 Cement : 2 Stone Dust).	0.196 Bags Per Square Meter
f.	25 mm. thick cast iron grid flooring using grid tiles of required size weighing 47 kg. per square meter on bed of 12 mm. thick cement concrete 1:2 (1 Cement : 2 Stone Aggregate 6 mm. nominal size) including filling the hollows with cement concrete same mix and tamping with 10 mm. dia. iron bars and grouting the joints with neat cement slurry complete.	0.025 Bags Per Square Meter
g.	Filling cement concrete 1:2:4 (1 Cement :2 Coarse Sand : 4 Graded Stone Aggregate 12.5 mm. nominal size) in gaps of A.C.Sheet corrugations and wings of ridges.	3.82 Bags Per Square Meter
29.	Cement Plaster	
a.	12 mm. 1:3 (1 Cement: 3 Sand).	14.68 Per 100 Square Meter
b.	12 mm. 1:4 (1 Cement: 4 Sand).	10.94 Per 100 Square Meter
c.	12 mm. 1:5 (1 Cement: 5 Sand).	8.92 Per 100 Square Meter
d.	12 mm. 1:6 (1 Cement: 5 Sand).	7.20 Per 100 Square Meter
e.	15 mm. 1:3 (1 Cement: 3 Sand).	17.54 Per 100 Square Meter
f.	15 mm. 1:4 (1 Cement: 4 Sand).	12.08 Per 100 Square Meter
g.	15 mm. 1:5 (1 Cement: 5 Sand).	10.66 Per 100 Square Meter
h.	12 mm. 1:6 (1 Cement: 6 Sand).	8.60 Per 100 Square Meter
i.	20 mm. 1:3 (1 Cement: 3 Sand).	22.84 Per 100 Square Meter
j.	20mm. 1:4 (1 Cement: 4 Sand).	17.02 Per 100 Square Meter
k.	20 mm. 1:5 (1 Cement: 5 Sand).	13.88 Per 100 Square Meter
l.	20 mm. 1:6 (1 Cement: 6 Sand).	11.20 Per 100 Square Meter
30.	Cement Plaster with a Floating Coat of neat cement	
a.	12 mm. 1:3 (1 Cement: 3 Sand).	19.08 Per 100 Square Meter
b.	12 mm. 1:4 (1 Cement: 4 Sand).	15.34 100 Per Square Meter
c.	12 mm. 1:3 (1 Cement: 3 Sand).	21.94 Per 100 Square Meter

d.	12 mm. 1:4 (1 Cement: 4 Sand).	17.48 Per 100 Square Meter
e.	15 mm. 1:3 (1 Cement: 3 Sand).	27.24 Per 100 Square Meter
f.	15 mm. 1:4 (1 Cement: 4 Sand).	21.42 Per 100 Square Meter
31.	Cement Plaster in two coats	
a.	20 mm. Cement Plaster in two coats under layer 12 mm. cement plaster 1:4 (1 Cement :4 Sand) finished with a top layer 8 mm. thick cement plaster 1:3 (1 Cement: 3 Sand)	20.00 Bags per 100 Square Meter
b.	18 mm. thick Cement Plaster in two coats under layer 12 mm. thick cement plaster 1:5 (1 Cement :5 Sand) finished with a top layer 6 mm. thick cement plaster 1:3 (1 Cement: 3 Sand)	16.26 Bags per 100 Square Meter
32.	6 mm. Cement Plaster	
a.	6 mm. Cement Plaster to ceiling 1:3 (1 Cement :3 Sand)	7.34 Bags per 100 Square Meter
b.	6 mm. Cement Plaster to ceiling 1:4 (1 Cement :4 Sand)	5.48 Bags per 100 Square Meter
c.	6 mm. Cement Plaster to ceiling 1:3 (1 Cement :3 Sand) finished with a floating coat of neat cement.	11.74 Bags per 100 Square Meter
d.	Neat Cement Punning.	4.40 Bags per 100 Square Meter
33.	Sand Cement Neeru Finished Plaster	
a.	Sand cement smooth neeru finished plaster for ceiling in cement mortar mix 1:4 (1 Cement :4 Sand), 10 to 15 mm. thick average, finished top smooth with neeru.	13.00 Bags per 100 Square Meter
b.	Sand cement smooth neeru finished plaster for walls in cement mortar mix 1:4 (1 Cement :4 Sand), 18 to 20 mm. thick average, finished top smooth with neeru.	19.00 Bags per 100 Square Meter
34.	Rough Cast Plaster	
	Rough Cast Plaster with a mixture of sand and gravel or crushed stone from 2.36 mm. to 12.5 mm. nominal size dashed over and including the fresh plaster in two layers, top layer 10 mm. cement plaster 1:3 (1 Cement: 3 Sand) mixed with 10% finely grounded hydrated lime by volume of cement and under layer 12 mm. cement plaster : 1:4 (1 Cement: 4 Sand)	
a.	With ordinary cement finish or cement pigment finish.	23.18 Bags per 100 Square Meter
b.	With white cement and pigment finish.	10.94 Bags Per 100 Sqm. (Grey Cement) 12.24 Bags Per 100 Sqm. (White Cement)
	1:5 Cement Sand (1 Cement:5 Sand)	
c.	With ordinary cement finish or cement and pigment finish.	21.16 Bags Per 100 Sqm. (Grey Cement)
d.	With white cement and pigment finish.	8.92 Bags Per 100 Sqm.(Grey Cement) 12.24 Bags Per 100 Sqm. (White Cement)

35.	Pointing on Stonework	
a.	Flush or ruled pointing on stone work with cement mortar 1:3 (1 Cement: 3 Sand)	2.34 Bags per 100 Square Meter
b.	Raised and cut pointing in stone work with cement mortar 1:3 (1 Cement: 3 Sand)	3.88 Bags per 100 Square Meter
36.	Waterproofing	
a.	Proprietary waterproofing treatment to the terrace with brickbat coba, cement base.	55.00 Bags per 100 Square Meter
b.	Proprietary waterproofing treatment to the canopy with brickbat coba, cement base.	45.00 Bags per 100 Square Meter
c.	Waterproofing chajja with sand cement plaster average 25 mm. thick in cement mortar 1:3 (1 Cement :3 Sand)	25.00 Bags per 100 Square Meter
d.	Proprietary waterproofing treatment to the sunk portion of toilet, cement base.	30.00 Bags per 100 Square Meter

No	Description of item of work.	Quantity of cement to be used per Unit Quantity of work.	Unit.
1.	Cast Iron Pipes		
	Providing and fixing on wall face C.I. rain water pipes including filling the joints with spun yarn soaked in neat cement slurry and cement mortar 1:2 (1 Cement: 2 Sand)		
a.	75 mm. dia pipe	0.132 Bags per 100 Running Meter	
b.	105 mm. dia pipe	0.176 Bags per 100 Running Meter	
c.	150 mm. dia pipe	0.264 Bags per 100 Running Meter	
2.	Cast Iron Accessories		
	Providing and fixing on wall face C.I. Accessories for rain water pipes including filling the joints with spun yarn soaked in neat cement slurry and cement mortar 1:2 (1 Cement : 2 Fine Sand)		
a.	75 mm. dia pipe C.I. Plain bend.	0.0052	Each
b.	100 mm. dia pipe C.I. Plain bend.	0.0062	Each
c.	150 mm. dia pipe C.I. Plain bend.	0.010	Each
d.	75 mm. dia C.I. head flat or corner type.	0.003	Each
e.	100 mm. dia C.I. head flat or corner type.	0.003	Each
f.	150 mm. dia C.I. head flat or corner type.	0.0052	Each
g.	75 mm. dia C.I. plain shoe.	0.003	Each
h.	100 mm. dia C.I. plain shoe.	0.003	Each
i.	150 mm. dia C.I. plain shoe.	0.0052	Each
j.	75 mm.dia C.I. single branch (plain)	0.0052	Each
k.	100 mm. dia C.I. single branch (plain)	0.0062	Each
l.	150 mm. dia C.I. single branch (plain)	0.0010	Each
m.	75 mm.dia C.I. double branch (plain)	0.008	Each
n.	100 mm. dia C.I. double branch (plain)	0.009	Each
o.	150 mm. dia C.I. double branch (plain)	0.0052	Each

p.	C.I. off-sets (plain) 75 mm. dia. 55 mm. projection.	0.0052	Each
q.	C.I. off-sets (plain) 75 mm. dia. 150 mm. projection.	0.0052	Each
r.	C.I. off-sets (plain) 100 mm. dia. 55 mm. projection.	0.0052	Each
s.	C.I. off-sets (plain) 100 mm. dia. 55 mm. projection.	0.0062	Each
t.	C.I. off-sets (plain) 100 mm. dia. 75 mm. projection.	0.0062	Each
3.	A.C. Fittings & Pipes		
	Providing and fixing on wall face asbestos cement rainwater pipes including jointing with spun yarn soaked in bitumen and cement mortar 1:2 (1 Cement 2 Coarse Sand) complete.		
a.	50 mm. dia.	0.150	Per 100 Running Meter
b.	80 mm. dia.	0.250	Per 100 Running Meter
c.	100 mm. dia.	0.300	Per 100 Running Meter
d.	150 mm. dia.	0.320	Per 100 Running Meter
e.	Providing and fixing A.C. Pipe (or any diameter) wall plugs and standard holder bat clamps comprising of two semi-circular halves of flat and cast-iron base screwed on wooden plugs.	0.0004	Per 100 Running Meter
f.	Providing and fixing on wall face asbestos cement rainwater pipes including jointing with spun yarn soaked in bitumen and cement mortar 1:2 (1 Cement 2 Coarse Sand) complete.		

		50 mm. (2”)	80 mm. (3”)	100 mm. (4”)	Unit
g.	Bend of required degree with door or without door.	0.0072	0.012	0.015	Each
h.	Off-set 52.2 mm. projection.	0.0058	0.0090	0.0116	Each
i.	Off-set 76.2 mm. projection.	0.0058	0.0090	0.011	Each
j.	Off-set 114.3 mm. projection.	0.0058	0.0090	0.0116	Each
k.	Off-set 152.4 mm. projection.	0.0058	0.0090	0.0116	Each
l.	Off-set 228.6 mm. projection.	0.0058	0.0090	0.0116	Each
m.	Off-set 304.8 mm. projection.	--	0.0090	0.0116	Each
n.	Off-set 457.2 mm. projection.	--	0.0090	0.0116	Each
o.	Off-set 609.6 mm. projection.	--	--	0.0116	Each
p.	Junction equal single of required degree with or without door.	0.0072	0.0116	0.0146	Each
q.	Junction equal double with or without door or required degree.	0.0108	0.0174	0.0220	Each
r.	Standard shoe.	0.00400	0.0058	0.0058	Each

4.	Sanitary Fittings		
a.	Fixing long pan pattern or Orissa pattern squatting pan or pedestal type water closet 12.5 liters or 15 liters flushing cistern and brackets, telescopic flush pipe or bend with fittings and clamps, overflow pipe with specials and mosquito proof coupling complete including cutting and making good the walls	0.10	Each

	and floors.		
	Fixing flat back or wall corner type, lipped front, urinal basin of 430 x 260 x 350 mm. and 340 x 430 x 265 mm. size respectively, white glazed earthenware with automatic C.I. flushing cistern with fittings, brackets, standard size flush pipe and spreaders with brass union and G.I. clamps complete including painting of cistern and fittings, cutting and making good the walls and floors.	0.050	Each
b.	One urinal basin with 5 liters C.I. automatic flushing cistern.	0.050	Each
c.	Range of two urinal basins with 10 liters C.I. automatic flushing cistern.	0.08	Each
d.	Range of three urinal basins with 10 liters C.I. automatic flushing cistern.	0.134	Each
e.	Range of four urinal basins with 15 liters C.I. automatic flushing cistern.	0.190	Each
	Fixing white glazed fire clay stall urinal with automatic C.I. flushing cistern with fittings R.S. or C.I. brackets standard size C.P. brass flush pipe and spreaders with unions and clamps, C.I. trap with outlet grating and other coupling in C.P. brass including painting of cistern and fittings, cutting and making good the walls and floors.		
f.	Single stall urinal with 5 liters C.I. automatic flushing cistern.	0.102	Each
g.	Range of two urinal basins with 10 liters C.I. automatic flushing cistern.	0.204	Each
h.	Range of three urinal basins with 10 liters C.I. automatic flushing cistern.	0.306 Bags	Each
i.	Range of four urinal basins with 15 liters C.I. automatic flushing cistern.	0.406 Bags	Each
	Fixing one-piece construction white squatting plate urinal with an integral longitudinal flushing pipe 100 mm. dia. half round channel automatic C.I. flushing cistern with fittings R.S. or C.I. brackets, standard size. G.I. flush pipe for back and front flush with standard spreader pipes with fittings G.I. clamps, white vitreous tiling 1200 mm. high to the front and side walls with white vitreous china corners and angles set in neat cement, standard urinals C.I. trap 65 mm. diameter with vent arm and outlet grating and coupling in C.P. brass complete, including painting the cistern and fittings and making good the walls and floors.		
j.	Single squatting plate with 5 liters C.I. automatic flushing cistern.	0.102 Bags	Each
k.	Range of two squatting plates with 10 liters C.I. automatic flushing cistern.	0.204 Bags	Each
l.	Range of three squatting plates with 10 liters C.I. automatic flushing cistern.	0.306 Bags	Each

m.	Range of four squatting plates with 15 liters C.I. automatic flushing cistern.	0.406 Bags	Each
n.	Fixing lavatory basin with brackets, pillar taps, rubber plug, waste of standard pattern, trap and unions complete including cutting and making good the walls.	0.050 Bags	Each
o.	Fixing white pedestal for wash basin completely recessed at the back for reception of pipes and fittings.	0.032 Bags	Each
p.	Fixing sink with brackets, 40 mm. rubber plus, brass chain, waste, trap with necessary unions complete including cutting and making good the walls.	0.050 Bags	Each
q.	Fixing teal-wood draining board with skirting and beading, wax polished with brackets painted white complete including making good the walls.	0.028 Bags	Each
5.	Sanitary Fittings (Items separately ordered)		
a.	Fixing long pan pattern or Orissa pattern squatting, or pedestal type W.C. pan.	0.050 Bags	Each
b.	Fixing a pair of white glazed earthenware or vitreous china footrests of standard pattern for Indian type W.C. pan.	0.010 Bags	Each
c.	Fixing flat back or wall corner type lipped front urinal basin of 430 x 260 x 350 mm. and 340 x 430 x 265 mm.	0.020 Bags	Each
d.	Fixing white glazed fire clay stall urinal of standard size.	0.04 Bags	Each
e.	Fixing white squatting plate urinal with integral longitudinal flush pipe. .	0.040 Bags	Each
f.	Fixing wash basin including making all connections excluding cost of fittings.	0.030 Bags	Each
g.	Fixing kitchen sink including making all connections complete.	0.030 Bags	Each
h.	Fixing in position 32 mm. diameter glavanised steel telescopic flush pipe complete including cutting and making good the walls and floor.	0.020 Bags	Each
6.	Sand Cast Iron Pipe and Fittings		
a.	Fixing M.S. holder bat clamp to 100 mm. dia. sand cast iron pipe embedded in cement concrete blocks 10 x 10 x 10 cm. of cement concrete 1:2:4 (1 Cement: 2 Sand : 4 Stone Aggregate) including cost of cutting holes and making good the walls etc.	0.010 Bags	Each
b.	Fixing M.S. stays and clamps for 100 mm. diameter sand cast iron pipe.	0.010 Bags	Each
c.	Fixing M.S. holder bat clamps for 50 mm. diameter sand cast iron pipe embedded in cement concrete block 10 x 10 x 10 cm. of 1:2:4 (1 Cement: 2 Sand : 4 Stone Aggregate) including cost of cutting holes and	0.010 Bags	Each
	making good the walls etc.		
d.	Fixing M.S. stays and clamps for 50 mm. diameter sand cast iron pipe.	0.010 Bags	Each

e.	Fixing sand cast iron trap 100 mm. inlet 100 mm. outlet of self-cleaning design with sand cast iron screwed down or hinged grating with or without vent arm complete including cost of cutting without and making good the walls and floor.	0.050 Bags	Each
f.	Fixing 100 mm. inlet and 50 mm. outlet sand cast iron floor trap of self-cleaning design with sand cast iron screwed down or hinged grating with or without vent arm complete including cost of cutting and making good the walls and floors.	0.050 Bags	Each
7.	Asbestos Cement Soil, Waste and Vent Pipes and Fittings		
	Providing and fixing on wall face asbestos cement soil waste and vent pipe including jointing with spun yarn soaked in bitumen and cement mortar 1:2 (1 Cement: 2 Sand) complete.		
a.	For 100 mm. diameter.	0.300 Bags	100 Meter
b.	For 50 mm. diameter.	0.150 Bags	100 Meter
	Fixing wooden plugs and standards holder bat clamps comprising of two semicircular halves of flat iron and cast-iron base screwed on wooden plugs.		
c.	For 100 mm. diameter.	0.0004 Bags	Each
d.	For 50 mm. diameter.	0.0004 Bags	Each
	Providing and fixing A.C. bends of required degree with access door insertion rubber washer 3 mm. thick, bolts and nuts or plain bend of heel rest unitary bend including jointing with spun yarn soaked in bitumen and cement mortar 1:2 (1 Cement: 2 Sand)		
e.	For 100 mm. diameter.	0.0020 Bags	Each
f.	For 50 mm. diameter.	0.0010 Bags	Each
	Providing and fixing double equal or unequal A.C. junctions of required degree plain or with access door, insertion, rubber washer 3 mm. thick bolts and nuts, including jointing with spun yarn cement mortar 1:2 (1 Cement: 2 Sand) complete.		
g.	100 x 100 x 100 x 100 mm. double equal junctions or 100 x 100 x 50 x 50 mm. double unequal junctions.	0.004 Bags	Each
h.	50 x 50 x 50 50 mm. double equal junctions.	0.002 Bags	Each
	Providing and fixing single equal or unequal A.C. junctions of required degree plain or with access door, insertion, rubber washer 3 mm. thick bolts and nuts, including jointing with spun yarn cement mortar 1:2 (1 Cement: 2 Sand) complete.		
i.	100 x 100 x 100 x 100 mm. single equal junctions or 100 x 100 x 50 x 50 mm. single unequal junctions.	0.0030 Bags	Each
j.	50 x 50 x 50 50 mm. single equal	0.0016 Bags	Each

	junctions.		
	Providing and fixing plain A.C. invert branch of required degree including jointing with spun yarn soaked in bitumen and cement mortar 1:2 (1 Cement: 2 sand).		
l.	50 x 50 x 50 x 50 mm.	0.002 Bags	Each
m.	50 x 50 x 50 x 50 mm.	0.0016 Bags	Each
	Providing and fixing A.C. offset including jointing with spun yarn soaked in bitumen and cement mortar 1:2 (1 Cement: 2 Sand)		
n.	100 mm. dia. A.C. offset with any projection.	0.002 Bags	Each
o.	50 mm. dia. A.C. offset with any projection.	0.0010 Bags	Each
	Providing and fixing A.C. loose socket including jointing with spun yarn soaked in bitumen and cement mortar 1:2 (1 Cement: 2 Sand) complete.		
p.	100 mm.	0.002 Bags	Each
q.	50 mm.	0.0010 Bags	Each
	Providing and fixing A.C. Terminal guard including jointing with spun yarn soaked in bitumen and cement mortar 1:2 (1 Cement: 2 Sand).		
r.	100 mm.	0.002 Bags	Each
s.	50 mm.	0.0010 Bags	Each
t.	Cutting chase in brick masonry walls for fixing 100 mm diameter sand cast iron pipes and making good the same with brick work in cement mortar 1:3 (1 Cement: 3 Sand)	10.00 Bags	100 Meter
u	Cutting chase in brick masonry walls for fixing 50 mm. diameter sand cast iron pipes and making good the same with the brick work in cement mortar 1:3 (1 Cement: 3 Sand).	6.66 Bags	100 Meter
8.	Drainage		
	Jointing glazed stone ware pipes grade “A” with stiff mixture of cement mortar in the proportion of 1:1 (1 Cement: 1 Sand)		
a.	100 mm. dia.	4.34 Bags	100 Meter
b.	150 mm. dia.	6.46 Bags	100 Meter
c.	200 mm. dia.	8.66 Bags	100 Meter
d.	230 mm. dia.	9.74 Bags	100 Meter
e.	250 mm. dia.	10.80 Bags	100 Meter
f.	300 mm. dia.	12.94 Bags	100 Meter
g.	450 mm. dia.	19.54 Bags	100 Meter
	Laying cement concrete 1:5:10 (1 Cement: 5 Sand : 10 Graded Stone Aggregate 40 mm. nominal size) around S.W. pipe including bed concrete 15 cm. thick.:		
h.	100 mm. dia. S.W. Pipe.	47.32 Bags	100 Meter
i.	150 mm. dia. S.W. Pipe.	50.70 Bags	100 Meter
j.	200 mm. dia. S.W. Pipe.	58.24 Bags	100 Meter
k.	230 mm. dia. S.W. Pipe.	62.92 Bags	100 Meter
l.	250 mm. dia. S.W. Pipe.	66.04 Bags	100 Meter
m.	300 mm. dia. S.W. Pipe.	73.58 Bags	100 Meter
n.	350 mm. dia. S.W. Pipe.	81.12 Bags	100 Meter
o.	400 mm. dia. S.W. Pipe.	88.40 Bags	100 Meter

p.	450 mm. dia. S.W. Pipe.	96.20 Bags	100 Meter
	Laying cement concrete 1:5:10 (1 Cement: 5 Sand : 10 Graded Stone Aggregate 40 mm. nominal size) up to haunches of S.W. pipe including bed concrete 15 cm. thick.:		
q.	100 mm. dia. S.W. Pipe.	31.72 Bags	100 Meter
r.	150 mm. dia. S.W. Pipe.	34.84 Bags	100 Meter
s.	200 mm. dia. S.W. Pipe.	40.56 Bags	100 Meter
t.	230 mm. dia. S.W. Pipe.	44.20 Bags	100 Meter
u.	250 mm. dia. S.W. Pipe.	46.54 Bags	100 Meter
v.	300 mm. dia. S.W. Pipe.	52.26 Bags	100 Meter
w.	350 mm. dia. S.W. Pipe.	58.24 Bags	100 Meter
x.	400 mm. dia. S.W. Pipe.	62.96 Bags	100 Meter
y.	450 mm. dia. S.W. Pipe.	69.94 Bags	100 Meter
z.	Laying light duty non-pressure NP2 or P1 class R.C.C. pipes with collars jointed with stiff mixture of cement mixture of cement mortar in the proportion of 1:2 (1 Cement: 2 Sand) including joints etc.		
Z1.	100 mm. dia. R.C.C. pipe (NP2) or (P1)	1.00 Bags	100 Meter
Z2.	150 mm. dia. R.C.C. pipe (NP2) or (P1)	1.20 Bags	100 Meter
Z3	250 mm. dia. R.C.C. pipe (NP2) or (P1)	1.80 Bags	100 Meter
Z4.	300 mm. dia. R.C.C. pipe (NP2) or (P1)	2.20 Bags	100 Meter
Z5.	450 mm. dia. R.C.C. pipe (NP2) or (P1)	4.80 Bags	100 Meter
Z6.	500 mm. dia. R.C.C. pipe (NP2) or (P1)	5.20 Bags	100 Meter
Z7.	600 mm. dia. R.C.C. pipe (NP2) or (P1)	6.40 Bags	100 Meter
Z8.	700 mm. dia. R.C.C. pipe (NP2) or (P1)	7.40 Bags	100 Meter
Z9.	800 mm. dia. R.C.C. pipe (NP2) or (P1)	8.40 Bags	100 Meter
Z10	900 mm. dia. R.C.C. pipe (NP2) or (P1)	9.80 Bags	100 Meter
Z11	1000 mm. dia. R.C.C. pipe (NP2) or (P1)	11.00 Bags	100 Meter

TECHNICAL SPECIFICATIONS OF PLUMBING WORKS

1. BASIS OF DESIGN

The Plumbing, External Drainage and water supply System for the project is designed keeping in view the following:

1.1 Requirement of adequate and equal pressure availability of hot and cold-water lines in Public Toilets, Kitchen and other identified areas.

1.2 Adequate storage of water in underground raw + overhead treated domestic water tanks.

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

1.4 Landscape layout.

The execution of works and materials used shall be as per the latest relevant I.S. specifications. Wherever reference has been made to Indian Standard or any other specifications, the same shall mean to refer to the latest specification irrespective of any particular edition of such specification being mentioned in the specifications below or Schedule of Quantities.

2. CONCEPT OF THE SYSTEM

f) The following services are envisaged for the complex:

2.1 Water Treatment System for meeting the domestic water quality requirement with chemical parameters in acceptable limits as per IS:10500 which is considered safe for human consumption.

2.2 Domestic/Flushing water supply through Hydropneumatic system.

2.3 Sewage and Sullage collection system based on IS:1742 and applicable standards for domestic drainage and connected to Sewage Treatment Plant and /or as otherwise specified with outfall into municipal system.

2.4 Storm / Rain water drainage system from various levels of the building and disposal to Rain Water Harvesting System / storm water drain.

3. WATER STORAGE & DISTRIBUTION SYSTEM

3.1 **Water Requirement**

The water requirement for this project is proposed to be as per the provisions in IS : 1172 and prevalent practices.

3.2 **Source of Water**

It is expected that part of the daily domestic water requirement shall be through municipal mains supply. The rest will be obtained from bore wells/tankers.

3.4 **Appurtenant**

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

i. Automatic air vent
ii. Pressure Gauge.

iii. Water Hammer arrestors.

4. WORKMANSHIP

The workmanship shall be best of its kind and shall confirm to the specifications, as below or Indian Standard Specifications in every respect or latest trade practices and shall be subject to approval of the Owner's Site Representative. All materials and/or workmanship which in the opinion of the Owner's Site Representative / Architect / Consultant are defective or unsuitable shall be removed immediately from the site and shall be substituted with proper materials and/or workmanship forthwith.

5. MATERIALS

All materials shall be best of their kind and shall confirm to the latest Indian Standards.

All materials shall be of approved quality as per samples and origins approved by the Owner's Site Representative / Architect / Consultants.

As and when required by the Owner's Site Representative / Consultant, the contractor shall arrange to test the materials and/or portions of works at his own cost to prove their soundness and efficiency. If after tests any materials, work or portions or work are found defective or unsound by the Owner's Site Representative / Consultant, the contractor shall remove the defective material from the site, pull down and re-execute the works at his own cost to the satisfaction of the Owner's Site Representative / Consultant. To prove that the materials used are as specified the contractor shall furnish the Owner's Site Representative with original vouchers on demand.

GENERAL INSTRUCTIONS

1.0 GENERAL REQUIREMENTS

1.1 Scope of Work

1.1.1 The form of Contract shall be according to the "Conditions of Contract". The following clauses shall be considered as an extension and not in limitation of the obligation of the Contractor.

1.1.2 Work under this contract shall consist of furnishing all labour, materials, equipment and appliances necessary and required. The Contractor is required to completely furnish all the Plumbing and other specialized services as described hereinafter and as specified in the Schedule of Quantities and/or shown on the Plumbing Drawings.

1.1.3 Without restricting to the generally of the foregoing, the sanitary installations shall include the following: -

A. Plumbing Works

a. Sanitary ware Installation
b. Water Supply System (Hot & Cold).
c. Under ground water tanks with all sleeves.
d. Sewerage & Storm water drainage system.
e. Garden Irrigation System.
f. High side works.

1.1.4 Services rendered under this section shall be done without any extra charge.

1.2 Specifications

1.2.1 Work under this contract shall be carried out strictly in accordance with Specifications attached with the tender.

1.2.2 Items not covered under these Specifications due to any ambiguity or misprints, or additional works, the work shall be carried out as per Specifications of the latest Central Public Works Department with upto date amendments as applicable in the contract and or as per the requirement of the client or its representative.

1.2.3 Works not covered above in para 1.2.1 and 1.2.2 shall be carried out as per relevant Indian Standards and in case of its absence as per British Standard Code of Practice.

1.3. Execution of Work

1.3.1 The Contractor should visit and examine the site of work and satisfy himself as to the nature of the existing roads and other means of communication and other details pertaining to the work and local conditions and facilities for obtaining his own information on all matters affecting the execution of work. No extra charge made in consequence of any misunderstanding, incorrect information on any of these points or on ground of insufficient description will be allowed.

1.3.2 The work shall be carried out in conformity with the Plumbing drawings and within the requirements of Architectural, HVAC, Electrical, Structural and Other specialized services drawings.

1.3.3 The Contractor shall cooperate with all trades and agencies working on the site. He shall make provision for hangers, sleeves, structural openings and other requirements well in advance to prevent hold up of progress of the construction

schedule.

1.3.4 On award of the work, Contractor shall submit a schedule of construction in the form of a PERT Chart or BAR Chart for approval of the Project Manager/Architect/Consultant. All dates and time schedule agreed upon should be strictly adhered to, within the stipulated time of completion/commissioning along with the specified phasing, if any.

1.4 **Drawings**

1.4.1 Plumbing drawings are diagrammatic but shall be followed as closely as actual construction permits. Any deviations made shall be in conformity with the Architectural and other services drawings.

1.4.2 Architectural drawings shall take precedence over Plumbing or other services drawings as to all dimensions.

1.4.3 Contractor shall verify all dimensions at site and bring to the notice of the Project Manager all discrepancies or deviations noticed. Decision of the Project Manager shall be final.

1.4.4 Large size details and manufacturers dimensions for materials to be incorporated shall take precedence over small scale drawings.

1.4.5 All drawings issued by the Architects/Consultant for the work are the property of the Architects/Consultant and shall not be lent, reproduced or used on any works other than intended without the written permission of the Architects/Consultant.

1.5 **Inspection and Testing of Materials**

1.5.1 Contractor shall be required, if requested, to produce manufacturers Test Certificate for the particular batch of materials supplied to him. The tests carried out shall be as per the relevant Indian Standards.

1.5.2 For examination and testing of materials and works at the site Contractor shall provide all Testing and Gauging Equipment necessary but not limited to the followings: -

a) Theodolite, Steel tapes
b) Dumpy level
c) Weighing machine
d) Plumb bobs, Spirit levels, Hammers
e) Micrometers, Tachometers
f) Thermometers, Stoves
g) Hydraulic test machine
h) Smoke test machine

1.5.3 All such equipment shall be tested for calibration at any approved laboratory, if required by the Project Manager.

1.5.4 All Testing Equipment shall be preferably located in a special room meant for the purpose.

1.5.5 Samples of all materials shall be got approved before placing order and the approved samples shall be deposited with the Architects or kept at site in a sample room as prepared by the owners. Any materials declared defective by Project Manager/Architect/Consultant shall be removed from the site within 48 hours.

1.6 **Metric Conversion**

1.6.1 All dimensions and sizes of materials and equipment given in the tender document are commercial metric sizes.

1.6.2 Any weights, or sizes given in the tender having changed due to metric conversion, the nearest equivalent sizes accepted by Indian Standards shall be acceptable without any additional cost.

1.7 Reference Points

1.7.1 Contractor shall provide permanent Bench Marks, Flag Tops and other reference points for the proper execution of work and these shall be preserved till the end of the work.

1.7.2 All such reference points shall be in relation to the levels and locations given in the Architectural and Plumbing drawings.

1.8 Reference Drawings

1.8.1 The Contractor shall maintain one set of all drawings issued to him as reference drawings. These shall not be used on site. All important drawings shall be mounted on boards and placed in racks indexed. No drawings shall be rolled.

1.8.2 All corrections, deviations and changes made on the site shall be shown on these reference drawings for final incorporation in the completion drawings. All changes to be made shall be initialed by the Project Manager or Architects.

1.9 Shop Drawings

1.9.1 The Contractor shall submit to the Project Manager three copies of the shop drawings.

1.9.2 Shop drawings shall be submitted under following conditions:-

(a) Showing any changes in layout in the plumbing drawings.

(b) Equipment layout, piping and wiring diagram.

(c) Manufacturer's or Contractor's fabrication drawings for any materials or equipment supplied by him.

1.9.3 The Contractor shall submit two copies of catalogues, manufacturer's drawings, equipment characteristics data or performance charts as required by the Project Manager.

1.10 Completion Drawings

1.10.1 On completion of work, Contractor shall submit one complete set of original tracings and two prints of "as built" drawings to the Project Manager. These drawings shall have the following information.

a) Run of all piping, diameters on all floors, vertical stacks and location of external services.

b) Ground and invert levels of all drainage pipes together with location of all manholes and connections upto outfall.

c) Run of all water supply lines with diameters, locations of control valves, access panels.

d) Location of all mechanical equipment with layout and piping connections.

No completion certificate shall be issued unless the above drawings are submitted.

1.10.2 Contractor shall provide two sets of catalogues, service manuals manufacturer's drawings, performance data and list of spare parts together with the name and address of the manufacturer for all electrical and mechanical equipment provided by him.

1.10.3 All “Warranty Cards” given by the manufacturers shall be handed over to the Project Manager.

1.11. **Contractors Rates**

1.11.1 Rates quoted in this tender shall be inclusive of cost of materials, labour, supervision, erection, tools, plant, scaffolding, service connections, transport to site, taxes, octroi and levies, breakage, wastage and all such expenses as may be necessary and required to completely do all the items of work and put them in a working condition.

1.11.2 Rates quoted are for all heights and depths and in all positions as may be required for this work.

1.11.3 All rates quoted must be for complete items inclusive of all such accessories, Fixtures and fixing arrangements, nuts, bolts, hangers as are a standard part of the particular item except where specially mentioned otherwise.

1.11.4 All rates quoted are inclusive of cutting holes and chases in walls and floors and making good the same with cement mortar/concrete/water proofing of appropriate mix and strength as directed by Project Manager. Contractor shall provide holes, sleeves and recesses in the concrete and masonry work as the work proceeds.

1.11.5 The Contractor shall furnish the Architects with vouchers and test certificates, on request, to prove that the materials as specified and to indicate that the rates at which the materials are purchased in order to work out the rate analysis of non-tendered items which he may be called upon to be carried out.

1.12 **PAYMENT TERMS**

The terms of payments shall be as below:

10% of Contract amount as mobilization advance against submission of Bank guarantee of equivalent amount valid till end of completion period.

60% of Contract amount prorata against supply of materials at site.

10% Contract amount prorata against erection & Testing.

10% on testing, commission & handover of entire system.

10% Contract amount after handing over of all approvals as built drawings designs maintenance manuals and submission of Bank Guarantee of 2.5% and cash deposit of 2.5% of final value of work done (including extra items) valid till successful completion of Defect Liability period.

1.13 **Testing**

1.13.1 Piping and drainage works shall be tested as specified under the relevant clause(s) of the specifications.

1.13.2 Tests shall be performed in the presence of the Project Manager/ Consultant.

1.13.3 All materials and equipment found defective shall be replaced and whole work tested to meet the requirements of the specifications.

1.13.4 Contractor shall perform all such tests as may be necessary and required by the local authorities to meet Municipal or other bye-laws in force.

1.13.5 Contractor shall provide all labour, equipment and materials for the performance of the tests.

1.14 **Site Clearance and Cleanup**

1.14.1 The Contractor shall, from time to time clear away all debris and excess materials accumulated at the site.

1.14.2 After the Fixtures, equipment and appliances have been installed and commissioned, Contractor shall clean-up the same and remove all plaster, paints stains, stickers and other foreign matter of discoloration leaving the same in a ready to use condition.

1.14.3 On completion of all works, Contractor shall demolish all stores, remove all surplus materials and leave the site in a broom clean condition, failing which the same shall be done at Contractors risk and cost.

1.15 **License Permits and Authorities**

1.15.1 Contractor must keep constant liaison with the Municipal/statutory authority and obtain all approval of all drainage, water supply and other works carried out by him.

1.15.2 Contractor shall obtain, from the Municipal and other authority's necessary completion certificate(s) with respect to his work as required for occupation of the building. Contractor shall obtain permanent water supply and drainage connections from authorities concerned. Employer shall pay all fees/deposits as required to be paid to the authorities towards connection charges.

1.16 **Recovery of Cost for Materials issued to Contractors Free of Cost**

1.16.1 If any materials issued to the Contractor free of cost, are damaged or pilfered, the cost of the same shall be recovered from the Contractor on the basis of actual cost to owner which shall include all freight and transportation, excise duty, sales tax, octroi, import duty etc. plus 100%. The decision on the actual cost given by the Employer shall be final and binding on the Contractor.

1.17 **Cutting of Water Proofing Membrane**

No walls, terraces shall be cut for making and opening after water proofing has been done without written approval of Project Manager/Architects. Cutting of water proofing membrane shall be done very carefully to ensure that other portion(s) of water proofing is (are) not damaged. On completion of work at such place the water proofing membrane shall be made good and ensured that the opening/cutting is made fully water proof as per specifications and details of water proofing approved by Architects.

1.18 **Cutting of Structural Members**

No structural member shall be chased or cut without the written permission of the Project Manager.

1.19. **Materials Supplied by Owner**

1.19.1 The Contractor shall verify that all materials supplied by the Employer confirm to the specifications of the relevant item in the tender. Any discrepancy found shall be brought to the notice of the Project Manager.

SANITARY FIXTURES

2.1 SCOPE OF WORK

2.1.1 Work under this section shall consist of furnishing all material and labour as necessary and required to completely install all sanitary fixtures, brass and chromium plated fittings and accessories as required by the drawings and specified hereinafter or given in the schedule of quantities.

2.1.2 Without restricting to the generally of the foregoing the sanitary fixtures shall include all sanitary fixtures, C.P. fittings and accessories etc. necessary and required for the building.

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

2.2 GENERAL REQUIREMENTS

2.2.1 All fixtures and fittings shall be provided with all such accessories as are required to complete the item in working condition whether specifically mentioned or not in the schedule of quantities, specifications, drawings or not.

2.2.2 All fixtures and accessories shall be fixed in accordance with a set pattern matching the tiles or interior finish as per architectural/interior designers requirements. Wherever necessary the fittings shall centered to dimensions and pattern desired.

2.2.3 Fixing screws shall be half round head chromium plated brass with C.P. washers wherever required as per directions of Architect.

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

2.2.5 When directed, contractor shall install fixtures and accessories in a mock-up room for the approval of the Architect. Sample room fixtures may be reused on the works if undamaged, but no additional payment for fixing or dismantling shall be admissible.

2.3. INDIAN W.C.

2.3.1 Indian W.C. pan shall be Orissa pattern of size as specified in the schedule of quantities. Each W.C. shall be provided with a 100mm dia cast iron or porcelain P or S trap with or without vent horn.

2.3.2 W.C. shall be flushed by means of a C.I. high level flushing cistern or low level cistern of polyethylene body complete with accessories on an exposed or concealed type flush valve or as specified in bill of quantities.

2.3.3 The W.C. shall be fixed in level in a neat workmanlike manner. The W.C. and trap shall be set in cement concrete 1:2:4 mix (1 cement: 2 coarse sand: 4 stone aggregate 20mm nominal size). Joints between W.C. and flush pipe shall be made with a putty or white lead and linseed oil and caulked well or with an approved rubber joint.

2.4 ANGLO INDIAN W.C.

2.4.1 Anglo Indian W.C. shall be wash down type 'P' or 'S' Trap set.

2.4.2 Each Anglo Indian W.C. set shall be provided with a solid plastic seat with cover of colour given in the schedule of quantities, rubber buffers and chromium plated hinges.

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

2.4.4 Each Anglo Indian W.C. shall be flushed with a porcelain flushing cistern or an exposed or concealed type flush valve. Flush pipe/bend shall be connected to the W.C. by means of a suitable rubber adapter.

2.5. EUROPEAN W.C.

2.5.1 European W.C. shall be wash down, single or double siphonic type, floor or wall mounted set, flushed by means of porcelain low level flushing cistern, or an exposed or concealed type flush valve, as specified in schedule of quantities. Flush pipe/bend shall be connected to the W.C. by means of suitable rubber adapter. Wall hung w.c. shall be supported by C.I. floor mounted chair or chair frame as supplied by sanitary ware manufacturer.

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

2.**6 URINALS**

2.6.1 Urinals shall be lipid type half shall white glazed vitreous China of approx. size 630x420x380mm size or as specified in bill of quantities.

2.6.2 Half stall Urinals shall be provided with 15mm dia C.P. spreader, 32mm dia C.P domical waste and C.P. cast brass bottle trap with pipe and wall flange, and shall be fixed to wall by one C.I. bracket and two C.I. wall clips as recommended by manufacturers complete as directed by Architect.

2.6.3 Half stall urinals shall be fixed with C.P. brass screws and shall be provided with 32mm dia domical waste leading to urinals trap.

2.6.4 Urinals shall be flushed by means of automatic porcelain flushing cistern or exposed or concealed type urinal flush valve, as specified in schedule of quantities.

2.6.5 Flushing cistern for urinals shall be automatic type cast iron or vitreous china as given in the schedule of quantities. Each flushing cistern shall have a copper siphon and inlet noose cock to control the flow. Flushing cistern shall be fixed to wall with R.S. or C.I. brackets. Cast iron cistern and brackets shall be painted with two coats of white enamel paint. Cistern may be concealed in pipe shafts or false ceilings where required as directed by Architect.

2.6.6 Flush pipes of flushing cistern with sizes of main and branch flush pipes shall be as follows:

No. of Urinals in range	Capacity of cistern litres	Size of main flush pipe	Size of branch flush pipe	Size of Connection to urinal
One	5	--	--	15
Two	10	20	--	15
Three	10	25	--	15

2.6.7 Alternatively, urinals may be flush with flush valves, exposed or concealed type.

2.6.8 Waste pipes for urinals shall be any one of the following:

a). G.I. pipes

b). Rigid P.V.C.

c). Lead pipes.

Waste pipes may be exposed on wall or concealed in chase as directed by the Architect. Specifications for waste pipes shall be same as given in sub-section 8.0 to 10.0 section-II of Volume-II.

2.7 LAVATORY BASIN

2.7.1 Lavatory basins shall be white glazed vitreous chine or polymarble of size, shape and type specified in the bill of quantities.

2.7.2 Each basin shall be provided with R.S. or C.I. brackets and clips and the basin securely fixed to wall. Placing of basins over the brackets without secure fixing shall not be accepted.

2.7.3 Each basin shall be provided with 32mm dia C.P. waste with overflow, pop-up waste or rubber plug and chain as given in the bill of quantities, 32mm dia C.P. Brass bottle trap with C.P. pipe to wall and flange.

2.7.4 Each basin shall be provided with fittings or mixing fitting as specified in the bill of quantities.

2.7.5 Basins shall be fixed at proper heights as shown on drawings. If height is not specified, the rim level shall be 79 cms above the floor or as directed by Architect.

2.8 SINKS

2.8.1 Sinks shall be of precast Terrazzo marble, or white glazed fireclay or vitreous china or stainless steel or any other material as specified in the schedule of quantities.

2.8.2 Each sink shall be provided with R.S. or C.I. brackets and clips and securely fixed. Counter top sinks shall be fixed with suitable angle iron clips or brackets as recommended by the manufacturer. Each sink shall be provided with 40mm dia C.P. waste with chain and plug or P.V.C. waste. Fixing shall be done as directed by Architect.

2.8.3 Supply fittings for sinks shall be mixing fittings or C.P. taps as specified in the bill of quantities.

2.9 MIRRORS

2.9.1 Mirrors shall be electro coated copper 5.5mm thick of guaranteed reputed make. The size shall be as specified in the bill of quantities or shown on the drawings. The image shall be clear and without waviness at all angles of vision.

2.9.2 Mirrors shall be provided with backing of 12mm thick marine plywood sheet fixed with C.P. brass semi-round headed screws and cup washers or C.P. brass clamps as specified or instructed by Architect.

2.10 SHOWER SET

2.10.1 Shower set shall comprise of one/two C.P. Brass concealed stop cocks with two long body brass/C.P. brass bib cock, or bath spout or as given in the bill of quantities.

2.10.2 Each shower set shall also be provided with C.P. Shower arm with wall flange and shower head of approved quality as specified in the bill of quantities.

2.10.3 Concealed stop cocks shall be so fixed as to keep the wall flange clear off the finished wall. Wall flanges embedded in the finishing shall not be accepted.

2.11 ACCESSORIES

2.11.1 Contractor shall install all chromium plated and porcelain accessories as shown on the drawings or directed by Architect, and given in the bill of quantities.

2.11.2 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 Architect.

2.11.3 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.

2.12 URINAL PARTITIONS

2.12.1 Urinal partitions shall be white glazed vitreous china or 25mm thick marble of size specified in the schedule of quantities.

2.12.2 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 Architect.

2.13 MEASUREMENT

2.13.1 Rate for providing and fixing of sanitary fixtures accessories, urinal partitions shall include all items and operations stated in the respective specifications and bill of quantities and nothing extra is payable.

2.13.2 Rates for all items under specifications para above shall be inclusive of cutting holes and chases and making good the same, C.P. screws, nuts, bolts and any fixing arrangements required and recommended by manufacturers, testing and commissioning.

3. SOIL, WASTE, VENT & RAINWATER PIPES & FITTINGS

3.1 Scope of Work

3.1.1 Work under this section shall consist of furnishing all labour, materials, equipments and appliances necessary and required to completely install all soil, waste, vent and rainwater pipes and fittings as required by the drawings, and given in the Schedule of Quantities.

3.1.2 Without restricting to the generally of the foregoing, the soil, waste, vent pipes system shall include the followings: -

1. Vertical and horizontal soil, waste and vent Pipes, and fittings, joints, clamps, connections to fixtures.
2. Connection of pipes to sewer lines as shown on the drawings at ground floor levels.
3. Floor and urinal traps, cleanout plugs, inlet fittings and rainwater heads /Khurras.
4. Testing of all pipe lines.

3.2. General Requirements

3.2.1 All materials shall be new of the best quality conforming to specifications and subject to the approval of Project Manager.

3.2.2 Pipes and fittings shall be fixed truly vertical, horizontal or in slopes as required in a neat workmanlike manner.

3.2.3 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.

3.2.4 Pipes shall be securely fixed to walls and ceilings by suitable clamps at intervals specified.

3.2.5 Access doors for fittings and cleanouts shall be so located that they are easily accessible for repair and maintenance. Any access panel required in the Civil structure, false ceiling or marble cladding etc. shall be clearly reported to the Owner in the form of shop drawings so that other agencies are instructed to provide the same.

3.3 Piping System

3.3.1 Soil, Waste and Vent Pipes

a) The soil and waste pipe system above ground has been planned as a "Two pipe system" having separate pipes for waste for kitchen sinks, wash basins, AHU's, condensate drains and floor drains and soil from the WCs and Urinals.

b) All waste water from AHU's plant and pump rooms, floor channels in basements (if any) will be provided with a deep seal trap before connecting to the main drain or vertical stack.

c) Vertical soil and waste stacks shall be connected to a separate horizontal drain / single horizontal drain at basement ceiling generally as shown on the drawings.

d) Toilet layouts have been so arranged that the W.C outlets shall be with "P" trap above ground level.

e) All soil/waste from areas in basement areas will be collected in sumps and pumped into sewer lines or as specifically designed.

f) Head (Starting point) of drains and sewage/waste water sumps (as and where applicable) having a length of greater than 4m upto connection to the main drain or manhole shall be provided with a 80/100mmvent pipe terminating above roof / a Maxi-Filtra with an ACF cartridge shall be provided close to the MH as directed by the Project Manager.

3.4 **Rainwater Pipes**

a) All open terraces shall be drained by rain water down takes.

b) Rainwater down takes are separate and independent of the soil and waste system and will discharge into the underground storm water drainage system of the complex.

c) Rainwater in open courtyards shall be collected in catch basins and connected to the storm water drains.

d) Any dry weather flow from waste appliances e.g. AHU's, Parking and Drainage Sumps shall connected to the Storm Water Network and Sewerage Sumps will be connected to the Sewerage System.

3.5 **Balcony/Planter Drainage**

Wherever required, all balconies, terraces, planters and other formal landscape areas will be drained by vertical down takes or other type of drainage system shown on the drawings and directed by the Project Manager.

3.6 **Soil Waste and Vent Pipes and Fittings above Ground**

3.7 **Noise Insulated Piping System** (Polypropylene piping**)**

3.7.1 **SOCKET PIPES**

Three Layer sound insulated Polypropylene low noise push-fit type, food safe pipes confirming to EN 1451 including all fittings & accessories such as coupler, elbow, tee, Y, reducer, access door, end cap, cowls, clamps, etc. for conveying soil, waste, vent & rainwater purpose in floors, ceiling suspended, or on walls, with leak proof joints etc. Joining pipes & fittings with SBR rubber sealing rings as per approved manufacturer recommendation. Sound level of less than or equal to 14 db(A) at flow rate of 4 L/s according to EN 14366. Material density should not be less than 1.9 gm/cm3. Modulus of elasticity 3800 N/mm2 & ring stiffness 21KN/m2. Tensile strength 16.8 N/mm2 & coef. of linear expansion 0.09 Mm/mk. MFR 2.1 gm/10 min. Fire resistance of D-s2, d0 as per EN 13501-1 & DIN 4102:B2. Joining method – Push fit sockets with factory inserted lip seal. Testing as per tender specifications/EIC.
(Size: 40mm - 200mm)

- INTERNAL LAYER:
  Of PP-C, hot water resistant to 97 degree C, tested in accordance to ON EN 1451-1 and DIN 19560, good heat and corrosion ageing stability as well as high chemical resistance and a smooth pipe inner-surface.

  Color: as per manufacturer

- INTERMEDIATE LAYER:
  Of PP-MV compound reinforced with mineral aggregate, which guarantees greater stiffness and stability.

  Color: as per manufacturer
- EXTERNAL LAYER:
  Of PP-C. With high impact resistance and good weathering resistance.

  Color: as per manufacturer

3.7.2 **PIPE RING STIFFNESS:**

Pipe ring stiffness would be in accordance with IS0/DIS 9969 and TIGHTNESS as per EN 1277/B and C and DIN 19560.

3.7.3 **MARKINGS:**

All pipes shall carry the following markings: Batch number; year and week of manufacture; company name; dimension application class; stiffness class, test mark and material details.

3.7.4 **FITTINGS:**

Single- Layered fitting reinforced with mineral aggregate, made of a Halogen free PP-C-KV synthetic material, a reinforced wall and factory fitted lip ring, hot water resistant upto 95 degree c in accordance to ON EN 1451 .

Color: as per manufacturer

3.7.5 **INSTALLATION:** The piping system must be clamped properly as required, pipes passing through walls, beams, slabs, columns should pass through sleeves which are padded with insulation material internally (between pipe and sleeve) covering the pipe to avoid transfer of body and structural borne sounds (refer manufacturer's installation guide lines). The piping must not touch any wall, structure, paneling, false ceiling etc.

Minimum supporting:

Nominal outer diameter DN/OD mm	Bracket distance	
	Horizontal pipe routing*) D max. m (max. 15 x da)	Vertical pipe routing*) D max. m
32	0,5	1,50
40	0,6	1,50
50	0,75	1,50
75	1,10	2,00
90	1,35	2,00
110	1,65	2,00
125	1,85	2,00
160	2,40	2,00
200	3,00	2,00
250	3,00	2,00

3.8 **<u>Traps</u>**

3.8.1 **Floor Traps**

Floor traps where specified shall be siphon type full bore Polypropylene having a minimum 50 mm deep seal. All traps are under slung from the slab and shall be adequately supported.

3.8.2 **Urinal Traps**

Urinal traps shall be siphon type full bore Polypropylene having a minimum 50 mm deep seal. All traps are under slung from the slab and shall be adequately supported.

3.8.3 **Cleanout Plugs**

Floor Clean Out and line clean out plugs

Clean out plug for soil, waste or rain water pipes laid under floors shall be provided near pipe junctions bends, tees, "Y" and on straight runs at such intervals as required as per site conditions. Clean out plugs shall terminate flush with the floor levels. Line clean outs shall be supported with manufacturer provided bracket. They shall be of push fit type of PKNG mane .

3.9 **<u>Drainage under floor/above floor (</u>**

3.9.1 All drainage lines passing under building, in exposed position above ground e.g. service floors, basement ceiling etc. shall be Multilayered as per details given in sub-clause 3.10 above or shall be as per details given below. Position of such pipes shall generally be shown on the drawings.

3.10.1 **SOCKET PIPES**

3 layer technology Polo-Eco Plus Premium 10 pipes and fittings for underground/ misc. drainage applications having external layer of PP-Blend + mineral reinforcement, supporting layer of PP + magnesium silicate and internal in PP with chemical resistance between 2-13pH and ring rigidity of =/> 10kN/m2 having OFI certification for longitudinal stability & impermeability of pie connection in line.

3.10.2 **FITTINGS**

3-layered reinforced polypropylene (PP) sewage pipes, halogen and lead free, with integral push-fit socket and factory-fitted lip ring, tested and monitored according to the Product . Fittings upto dimension DN/OD 200 are manufactured by injection molding (1-layer), above DN/OD 200 (250 and above)
the fittings are butt or extrusion welded by the manufacturer. Fabrication of fittings at site shall not be permitted.

3.10.3 **Pipe Joints**

Field-proven push-fit connection with improved and modified lip ring of high ageing-resistant shall be provided with the pipes and fittings for easy push-fit installation, installation procedure as given in clause 3.10 above shall be followed.

4. WATER SUPPLY SYSTEM

4.1 Scope of Work

4.1.1 Work under this section consists of furnishing all labour, materials equipment and appliances necessary and required to completely install the water supply system as required by the drawings, specified hereinafter and given in the Schedule of Quantities.

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

a) Distribution system from main supply headers to all fixtures and appliances for cold/hot water.

b) Cold water supply lines from tube-wells and city water connections to fire and underground water tanks.

c) Municipal water and Bore-well connections to U.G. water tanks.

d) Garden Irrigation system

e) Excavation and refilling of pipes trenches.

f) Pipe protection and painting.

g) Control valves, masonry chambers and other appurtenances.

h) Connections to all plumbing fixtures, tanks, appliances and Municipal mains

i) Inserts for RCC tank.

4.2 General Requirements

4.2.1 All materials shall be new of the best quality conforming to specifications. All works executed shall be to the satisfaction of the Project Manager.

4.2.2 Pipes and Fittings shall be fixed truly vertical, horizontal or in slopes as required in a neat workmanlike manner.

4.2.3 Short or Long bends shall be used on all main pipe lines as far as possible. Use of Elbows shall be restricted for short connections.

4.2.4 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.

4.2.5 Pipes shall be securely fixed to walls and ceilings by suitable clamps at intervals specified.

4.2.6 Clamps, hangers and supports on RCC walls, columns and slabs shall be fixed only by means of approved made of expandable metal fasteners inserted by use of power drills.

4.2.7 All pipe clamps, supports, nuts, bolts, washers shall be galvanized MS steel throughout the building. Painted MS clamps & MS nuts, bolts and washers shall not be accepted.

4.2.8 Valves and other appurtenances shall be so located as to provide easy accessibility for operations, maintenance and repairs.

4.3 **Water Supply System**

4.3.1 Contractor should study the site plan and water supply system diagram for an overview of the system.

4.3.2 Source

Water supply will be acquired from Municipal Corporation water mains to a service connection and captive tube-wells within the site and collected in water storage tanks located in basement.

4.4 **G.I. Pipes, Fittings & Valves (In Plant rooms and for Equipments)**

4.4.1 All pipes inside the buildings and where specified, outside the building shall be galvanized steel tubes conforming to I.S. 1239 of medium/ heavy class as specified in the BOQ.

4.4.2 Fittings shall be malleable iron with a reinforcing ring over the threaded ends upto 50mm dia and without reinforcing rings for sizes 65mm dia and above. Each fitting 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 conform to I.S:1879 (Part I to X).

4.4.3 Pipes and fittings shall be jointed with screwed joints. Care shall be taken to remove burr from the end of the pipe after reaming with a proper time.

4.4.4 Pipe threaded joints will be made by applying suitable grade of TEFLON tape used for drinking water supply.

4.4.5 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. No pipes shall be run inside a sunken floor as far as possible. Pipes may be run under the ceiling or floors and other as shown on drawings.

4.5 **Pipe Supports**

4.5.1 All pipes clamps, supports, hangers, rods, pipe supports, nuts and washers shall be factory made galvanized MS steel or alternatively galvanized after fabrication to suit site requirements.

4.5. 2 G.I pipes in shafts and other locations shall be supported by galvanized M.S clamps of design approved by pipes in wall chases shall be anchored by G.I hooks, pipes at ceiling level shall be supported on structural clamps fabricated from M.S structural steel. Pipes in typical shafts shall be supported on Galvanised slotted angles/channels as specified elsewhere.

4.6 **Clamps**

G.I. pipes in shafts and other locations shall be supported by M.S. clamps of design approved by Project Manager. Pipes in wall chases shall be anchored by iron hooks, Pipes at ceiling level shall be supported on structural clamps fabricated from M.S. structural steel as described above. Pipes in typical shafts shall be supported on slotted angles/channels as specified.

4.7 Anchor Fasteners

4.7.1 All pipe supports, hangers and clamps to be fixed on RCC walls, beams, columns, slabs and masonry walls 230mm thick and above by means of galvanised expandable anchor fasteners in drilled holes of correct size and model to carry the weight of pipes. Drilling shall be made only by approved type of power drill as recommend and approved by manufacturer of the anchor fasteners. Failure of any fastening devices shall be the entire responsibility and contractor shall redo or provide additional supports at his own cost. He shall also compensate the owner for any damage that may be caused by such failures.

4.8 **Unions**

Contractor shall provide adequate number of unions on all pipes to enable easy dismantling later when required. Unions shall be provided near each gunmetal valve, stop cock, or check valve and on straight runs as necessary at appropriate locations as required and/or directed by Project Manager.

4.9 **Flanges**

Flanged connections shall be provided on pipes as required or where shown on the drawings, all equipment connections as necessary and required or as directed by connections shall be made by the correct number and size of GI nuts, bolts & washers with 3 mm thick gasket. Where hot water or steam connections are made insertion, gasket shall be of suitable high temperature grade and quality approved by Bolt hole dia for flanges shall conform to match the specification for C.I. sluice valve to I.S.780. and C.I. butterfly valve to IS: 3095.

4.15 **CPVC Pipes and Fittings:**

Chlorinated Poly Vinyl Chloride (CPVC) compound shall meet cell class 23447 B as defined by ASTM D 1784 and have a design stress of 2000 psi and a maximum service temperature upto 93 degree Celsius. Pipes shall be as per SD 11, material as per ASTM 1784, specifications as per ASTM D2846 and cpvc jointing solvent shall be as per ASTM F493. SCHEDULE PIPES 40 and 80 shall be as per ASTM F441. (for Hot water and Cold water applications)
Clamping for cpvc pipe shall be as per manufacturer's recommendations only.

4.16 **Valves**

4.16.1 **Ball Valves**

Valves upto 50 mm dia. shall be screwed type Ball Valves with stainless steel balls spindle teflon seating and gland packing tested to a hydraulic pressure of 20 kg/sq.cm., and accompanying couplings and steel handles.(to BIS 5351)

4.17 Butterfly Valves – Slim Seal Type

4.17.1 Valves 65 mm dia and above shall be cast iron butterfly valve to be used for isolation. The valves shall be bubble tight, resilient seated suitable for flow in either direction and seal in both direction with accompanying flanges and steel handle.

4.17.2 Butterfly valve shall be of best quality conforming to IS: 13095.

4.18 Non Return Valve (Dual Slim Type)

Where specified, non return valve shall be provided through which flow shall occur in one direction only.

Each Butterfly and Slim Type Swing Check (NRV) Valve shall be provided with a pair of flanges screwed or welded to the main line and having the required number of nuts, bolts and washers of correct length.

4.18 Storage tanks Underground & Overhead Tank. (Accessories & Connections)

4.18.1 Storage tanks for water supply shall be in reinforced cement concrete built by the building contractor.

4.18.2 Each tank shall be provided with a 560mm Dia Heavy Duty Cast Iron manhole frame and cover.

4.19 **Storage Tanks**

4.19.1 Underground

Underground storage tanks for water supply shall be reinforced cement concrete built by the building contractor.

Each tank shall be provided with a 560mm Dia Heavy Duty Cast Iron manhole frame and cover or as approved by local municipal authority.

4.20 **Outlets and overflow**

All nozzles for puddle flanges in RCC tank for inlet, outlet, overflow and scour etc. shall be provided by civil contractor or as given in the Schedule of Quantities, further connections and accessories shall be provided under this contract.

4.21 **Testing**

All pipes, fittings and valves, after fixing at site, shall be tested by hydrostatic pressure of 1.5 times the working pressure or 7 kg / sq.cm whichever is higher. Pressure shall be maintained for a period of at least thirty minutes without any drop. A test register shall be maintained and all entries shall be signed and dated by Contractor (s) and Project Manager.

In addition to the sectional testing carried out during the construction, Contractor shall test the entire installation after connections to the overhead tanks or pumping system or mains. He shall rectify all leakages and shall replace all defective materials in the system. Any damage done due to carelessness, open or burst pipes' or failure of fittings, to the building, furniture and fixtures shall be made good by the Contractor during the defects liability period without any cost.

After commissioning of the water supply system, Contractor shall test each valve by closing and opening it a number of times to observe if it is working efficiently. Valves, which do not effectively operate, shall be replaced by new ones at no extra cost and the same shall be tested as above.

Hot water pipes chased into the walls shall be provided with a 6mm thick insulation with elastic flexible material having hermetic closed cell structure of expanded synthetic material rated for 60ºC hot water supply.

4.22 **Measurement**

a) Pipes above ground shall be measured per linear meter (to the nearest cm) and shall be inclusive of all fittings e.g. coupling, tees, bends, elbows, unions, flanges and U clamps with nuts, bolts & washers fixed to wall or other standard supports.

b) Jointing with teflon tape, white lead, solvent, crimping and insertion gasket of appropriate temperature grade.

c) Cutting holes, and chases in walls, floors, any pipe support required for pipes below ground & making good the same.

d) Excavation, backfilling, disposal of surplus earth and restoring the ground & floor in original condition.

4.23 **Pipe Supports**

Fabricated and / or galvanised supports shall be measured by weight. Weight for each type of clamp shall be calculated on basis of the quantity of structurals and MS used from the theoretical weight calculated on basis of the components theoretical weight of the sections.

4.24 Rate quoted for supports & hangers shall be inclusive of :

a) Expandable anchor fastens.
b) Galvanising of all supports & hangers.
c) Cutting holes in walls, ceilings on floors and making good where permitted.
d) Nuts, bolts and washers for fixing and assembling.
e) Wooden / PVC pipe saddles for vertical or horizontal runs.

4.25 **Valves**

Gunmetal, cast iron, butterfly and non-return valves and puddle flanges shall measured by numbers and shall include wheels I caps, GI nuts, bolts, washers, insertion gasket.

4.26 **Painting/pipe protection/insulation**

Painting/pipe protection /insulation for pipes shall be measured per linear meter over finished surface and shall include all valves and fittings for which no deduction shall be made. No extra payment shall be made for fittings, valves or flanges.

5.0 DRAINAGE (Sewers & Storm Water Drains)

5.1 Scope of work

5.1.1 Work under this section shall consist of furnishing all labour, materials, equipment and appliances necessary and required to completely install all the drainage system as required by the drawings and specified hereinafter or given in the Schedule of Quantities.

5.1.2 Without restricting to the generality of the foregoing, the drainage system shall include: -

5.1.2.1 Sewer lines including excavations, pipelines, manholes, drop connections and connections to the existing sewer.

5.1.2.2 Storm water drainage, excavation, pipelines, manholes, catch basins, drain channels and connections to the existing storm water drain.

5.2 General requirements

5.2.1 All materials shall be new of the best quality conforming to specifications and subject to the approval of the Project Manager.

5.2.2 Drainage lines and open drains shall be laid to the required gradients and profiles.

5.2.3 All drainage work shall be done in accordance with the local municipal bye-laws.

5.2.4 Contractor shall obtain necessary approval and permission for the drainage system from the municipal or any other competent authority.

5.2.5 Location of all manholes, etc. shall be got confirmed by the Contractor from the Architect / Landscape Architect. As far as possible, no drains or sewers shall be laid in the middle of road unless otherwise specifically shown on the drawings or directed by the Project Manager.

5.3 Excavation

5.3.1 Alignment and grade

The sewer pipes shall be laid to alignment and gradient shown on the drawings but subject to such modifications as shall be ordered by the Project Manager. No deviations from the lines, depths of cutting or gradients of sewers shown on the plans and sections shall be permitted except by the express direction in writing of the Project Manager.

5.3.2 Excavation in tunnels

The excavation for sewer works shall be open cutting only, unless the permission of the Project Manager is obtained for laying pipes in tunnel where sewers have to be constructed along narrow passages or difficult ground.

5.3.3 Opening out trenches

In excavating the trenches, etc. the solid road metalling, pavement, kerbing, etc. and turf is to be placed on one side and preserved for reinstatement when the trenches or other excavation shall be filled up. Before any road metal is replaced, it shall be carefully sifted. The surface of all trenches and holes shall be restored and maintained to the satisfaction of the Project Manager.

The Contractor shall grub up and clear the surface over the trenches and other excavations of all trees, stumps roots and all other encumbrances affecting execution of the work and shall remove them from the site to the approval of the

Project Manager.

5.3.4 Obstruction of roads

The Contractor shall not occupy or obstruct by his operation more than one half of the width of any road or street and sufficient space shall then be left for public and private transit, he shall remove the materials excavated and bring them back again when the trench is required to be refilled. The Contractor shall obtain the consent of the Project Manager.

5.3.5 Removal of filth

All night soil, filth or any other offensive matter met with during the execution of the works, immediately after it is taken out of any trench, sewer or cess pool, shall not be deposited on to the surface of any street or where it is likely to be a nuisance or passed into any sewer or drain but shall be at once put into the carts and remove to a suitable place to be provided by the Contractor.

5.3.6 Excavation to be taken to proper depths

The trenches shall be excavated to such a depth that the sewer shall rest on concrete as described in the several clauses relating thereto and so that the inverts may be at the levels given in the sections.

5.3.7 Refilling

After the sewer or other work has been laid and proved to be water tight, the trench or other excavations shall be refilled. Utmost care shall be taken in doing this, so that no damage shall be caused to the sewer and other permanent work. The filling in the haunches and upto 75cms above the crown of the sewer shall consist of the finest selected materials placed carefully in 15cms layers and flooded and consolidated. After this has been laid, the trench and other excavation shall be refilled carefully in 15cms layers with materials taken from the excavation, each layer is being watered to assist in the consolidation unless the Project Manager.

5.3.8 **Contractor to restore settlement and damages**

The contractor shall, at his own costs and charges make good promptly during the whole period the works are in hand, any settlement that may occur in the surfaces of roads, berms, footpaths, gardens, open spaces etc. Whether public or private caused by his trenches or by his other excavations and he shall be reliable for any accidents caused thereby. He shall also at his own cost and expenses and charges, repair any make of any damage done to the buildings and other property.

5.3.9 **Disposal of Surplus Earth**

The Contractor shall at his own costs and charges provide places for disposal of all surplus materials not required to be used on the works. As each trench is refilled the surplus soil shall be immediately removed, the surface properly restored and roadways and sides left clear.

5.3.10 **Timbering of sewer and trenches**

a) The contractor shall at all times support efficiently and effectively the sides of the sewer trenches and other excavations by suitable timbering, pilling and sheeting and they shall be closed, timbered in loose of sandy strata and below the surface of the sub soil water level.

b) All timbering, sheeting and piling with their walling and supports shall be of adequate dimensions and strength and fully braced and strutted so that no risk of collapse of subsidence of the walls of the trench shall be take place.

c) The contractor shall be held responsible and will be accountable for the sufficiency of all timbering, bracings, sheeting and piling used as also for, all damage to persons and property resulting from improper quality, strength, placing, maintaining or removing of the same.

5.3.11 **Shoring of Buildings**

The Contractor shall shore up all buildings, walls and other structures, the stability of which is liable to be endangered by the execution of the work and shall be fully responsible for all damages to persons or property resulting from any accident.

5.3.12 **Removal of water from sewer, trench etc**

a) The Contractor shall at all times during the progress of the work keep the trenches and excavations free from water which shall be disposed of by him in a manner as will neither cause injury to the public health nor to the public or private property nor to the work completed or in progress nor to the surface of any roads or streets, nor cause any interference with the use of the same by the public.

b) If any excavation is carried out at any point or points to a greater width than the specified cross section of the sewer with its envelope, the full width of the trench shall be filled with concrete by the Contractor at his own expenses.

5.3.13 **Width of trench**

5.3.14 Recommended width of trenches at the bottom shall be as follows: -

100 mm dia pipe	55 cms
150 mm dia pipe	55 cms
225-250 mm dia pipe	60 cms
300 mm dia pipe	75 cms

Maximum width of the bed concrete shall also be as above. No additional payment is admissible for widths greater than specified.

5.4 Salt glazed stoneware pipes (Where applicable)

5.4.1 Stoneware pipes shall be of first class quality salt glazed and free from rough texture inside and outside and straight. All pipes shall have the manufacturers name marked on it and shall comply to I.S. 65.1

5.4.2 **Laying and jointing of stoneware salt glazed pipes**

- Pipes are liable to be damaged in transit and notwithstanding tests that may have been made before dispatch each pipe shall be examined carefully on arrival at the site. Each pipe shall be rung with a wooden hammer or mallet and those that do not ring true and clear shall be rejected. Sound pipes shall be carefully stacked to prevent damage. All defective pipes should be segregated, marked in a conspicuous manner and their use in the works prevented.

- The pipes shall be laid with sockets leading uphill and rest on solid and even foundations for the full length of the barrel. Socket holes shall be formed in the foundation sufficiently deep to allow the pipe jointer room to work right round the pipe and as short as practicable to admit the socket and allow the joint to be made.

- Where pipes are not bedded on concrete the trench bottom shall be left slightly high and carefully bottomed up as pipe laying proceeds so that the pipe barrels rest on firm ground. If excavation has been carried too low it shall be made up with cement concrete at the Contractor's cost and charges.

- If the bottom of the trench consists of rock or very hard ground that cannot be easily excavated to a smooth surface, the pipes shall be laid on cement concrete bed to ensure even bearing.

5.4.3 Jointing of pipes

- Tarred gaskin shall first be wrapped round the spigot of each pipe and the spigot shall then be placed into the socket of the pipe previously laid, the pipe shall then be adjusted and fixed in its correct position and the gaskin caulked tightly home so as to fill not more than one quarter of the total length of the socket.

- The remainder of the socket shall be filled with stiff mix of cement mortar (I cement: I clear sharp washed sand). When the socket is filled, a fillet should be formed round the joint with a trowel forming an angle of 45 degrees with the barrel of the pipe. The mortar shall be mixed as needed for immediate use and no mortar shall be beaten up and used after it has begun to set.

- After the joint has been made any extraneous materials shall be removed from inside of the joint with a suitable scraper of "badger". The newly made joints shall be protected until set from the sun, drying winds, rain or dust. Sacking or other materials, which can be kept damp, shall be used. The joints shall be exposed and space left all round the pipes for inspection by the inside of the sewer must be left absolutely clear in bore and free from cement mortar or other obstructions throughout its entire length, and shall efficiently drain and discharge.

5.5 **uPVC Pipes & Fittings.**

a) Upvc pipes shall be straight and smooth conforming to IS 4985-1983 of class as specified in Schedule of Quantities.

b) Joints shall be done as per the manufacturer’s recommendations. The pipes and fittings must have matching dimension for perfect joints in the system shall be with solvent cement as per manufacturers requirements.

5.6 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 to 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 6-meter head at any point. The pipes shall be plugged preferably with standard design plugs with rubber plugs on both ends. The upper end shall, however, be connected to a pipe for filling with water and getting the required head.

- Sewer lines shall be tested for straightness by: (i) inserting a smooth ball 12 mm less than the internal diameter of the pipe. In the absence of obstructions such as yarn or mortar projecting at the joints the ball should roll down the invert of the pipe and emerge at the lower end. (ii) means of a mirror at one and a lamp at the other end. If the pipeline is straight the full circle of light will be seen otherwise obstruction of deviation will be apparent.

- The Contractor shall give a smoke test to the drains and sewer at his own expense and charges, if directed by the Project Manager.

  A test register shall be maintained which shall be signed and dated by Contractor.

5.7 Gully traps

Gully traps shall be of the same quality as described for stoneware pipes in clause 5.4.1 above and used where shown on drawings.

Gully traps shall be fixed in cement concrete 1:5:10 mix (1 cement: 5 coarse sand: 10 stone aggregate 40 mm nominal size) and a brick masonry chamber

30x30 cms inside plastered with cement mortar I:5 with 15x 15 cms grating inside and 30x30 cms C.I. sealed cover and frame weighing not less than 7.3 kg to be constructed as per standard drawing. Where necessary, sealed cover shall be replaced with C.I. grating of the same size.

5.8 Reinforced cement concrete pipes

- All underground storm water drainage pipes and sewer lines where specified (other than those specified cast iron) shall be centrifugally spun S & S RCC pipes of specified class. Pipes shall be true and straight with uniform bore, throughout. Cracked, warped pipes shall not be used on the work. All pipes shall be tested by the manufacturer and the Contractor shall produce, when directed a certificate to that effect from the manufacturer.

- **Laying**
  R.C.C. spun pipes shall be laid on cement concrete bed or cradles as specified and shown on the detailed drawings. The cradles may be precast and sufficiently cured to prevent cracks and breakage in handling. The invert of the cradles shall be left 12 mm below the invert level of the pipe properly placed on the soil to prevent any disturbance. The pipe shall then be placed on the bed concrete or cradles and set for the line and gradient by means of sight rails and bonding rods etc. Cradles or concrete bed may be omitted, if directed by the Project Manager.

- **Jointing**
  After setting out the pipes the socket shall be centered over the spigot and filled in with tarred gaskin, so that sufficient space is left on either side of the collar to receive the mortar. The space shall then be filled with cement mortar 1:2 (1 Cement: 2 fine sand) and caulked by means of proper tools. All joints shall be finished at an angle of 45 degrees to the longitudinal axis of the pipe on both sides of the collar neatly.

- **Testing**
  All pipes shall be tested to a hydraulic test of 1.5 m head for at least 30 minutes at the highest point in the section under test. Test shall also be carried out similar to those for stoneware pipes given above. The smoke test shall be carried out by the contractor, if directed by the Project Manager and a test register shall be maintained which shall be signed and dated by the Contractor/Project Manager.

5.9 **Cement Concrete and masonry works (For Manholes and Chambers)**

5.9.1 **Materials**

a) **Water**
Water used for all the construction purposes shall be clear and free from Oil, Acid, Alkali, Organic and other harmful matters, which shall deteriorate the strength and/or durability of the structure. In general, the water suitable for drinking purposes shall be considered good enough for construction purpose.

b) **Aggregate for Concrete**

The aggregate for concrete shall be in accordance with I.S. 383 and I.S. 515 in general, these shall be free from all impurities that may cause corrosion of the reinforcement. Before actual use these shall be washed in water, if required as per the direction of Project Manager. The size of the coarse aggregate shall be done as per I.S.383.

c) **Sand**

Sand for various constructional purposes shall comply in all respects with I.S 650 and I.S. 2116. It shall be clean, coarse hard and strong, sharp, durable, uncoated, free from any mixture of clay, dust, vegetable matters, mica, iron impurities soft or flaky and elongated particles, alkali, organic matters, salt, loam and other impurities which may be considered by the Project Manager.

d) **Cement**

The cement used for all the constructional purposes shall be ordinary Portland cement or rapid hardening Portland cement conforming to I.S. 269.

e) **Mild Steel Reinforcement**

The mild steel for the reinforcement bars shall be in the form of round bars conforming to all requirements of I.S. 432 (Grade I).

f) **Bricks**

Bricks shall have uniform color, thoroughly burnt but not over burnt, shall have plan rectangular faces with parallel sides and sharp right angled edges. They should give ringing sound when struck. Brick shall not absorb more than 20% to 22% of water, when immersed in water for 24 hours. Bricks to be used shall be approved by the Project Manager.

g) **Other Materials**

Other materials not fully specified in these specifications and which may be required in the work shall conform to the latest I.S. All such materials shall be approved by the Project Manager before use.

5.9.2 **Cement concrete (plain or reinforced)**

a) Cement concrete pipes bedding, cradles, foundations and R.C.C. slabs for all works shall be mixed by a mechanical mixer where quantities of the concrete poured at one time permit. Hand mixing on properly constructed platforms may be allowed for small quantities by the rate for cement concrete shall be inclusive of all shuttering and centering at all depth and heights.

b) Concrete work shall be of such thickness and mix as given in the Schedule of Quantities.

c) All concrete work shall be cured for a period or at least 7 days. Such work shall be kept moist by means of gunny bags at all times. All pipes trenches and foundations shall be kept dry during the curing period.

5.9.3 **Masonry**

Masonry work for manholes, chambers, septic tanks, and such other works as required shall be constructed from 1st class bricks or 2nd class as specified in the Schedule of quantities in cement mortar 1:5 mix (1 cement: 5 coarse sand). All joints shall be properly raked to receive plaster.

5.9.4 **Cement concrete for pipe support**

Wherever specified or shown on the drawing, all pipes shall be supported in bed all round or haunches. The thickness and mix of the concrete shall be given in the Schedule of Quantities. Width of the bedding shall be as per para 5.3.1.4.

Unless otherwise directed by the Project Engineer, cement concrete for bed, all-round or in haunches shall be laid as follows: -

	upto 1.5 m depth	**upto 3 m depth**	**beyond 3 m depth**
Stoneware pipes In open ground (no sub soil water)	All round (1:4:8)	Haunches (1:4:8)	All round (1:4:8)

R.C.C or SW (In sub soil water)	All round (1:3:6)	Haunches (13:6)	Haunches (1:3:6)
C.I Pipes (In all conditions)	All round (1:3:6)	Haunches (13:6)	Haunches (1:3:6)
R.C.C Pipes Or C.I Pipes Under or building	All round (1:3:6)	All round (13:6)	All round (1:3:6)

(Ratio refer to cement: coarse sand: stone aggregate 40 mm nominal size)

R.C.C pipes or C.I. pipes may be supported on brick masonry or precast R.C.C or in situ cradles. Cradles shall be shown on the drawings. Pipes in loose soil or above ground shall be supported on brick or stone masonry pillars as shown on the drawings.

5.10 **Manholes and chambers**

5.10.1 All manholes, chambers and other such works as specified shall be constructed on brick masonry in cement mortar 1:5(1 cement: 5 coarse sand) as specified in the Schedule of Quantities.

5.10.2 All manholes and chambers, etc. shall be supported on base of cement concrete of such thickness and mix as given in the Schedule or Quantities or shown in the drawings.

Where not specified, manholes shall be constructed as follows:- (all dimensions internal clear in cms)

Size of manhole type	**90x80 Rect.**	**120x90 Rect.**	**91 dia Conical**	**122 dia Conical**
Maximum depth	120	240	167	168
Average thickness Of R.C.C slab	15	15	-	-
Size of cover and frame cms	60x45	50 dia	50 dia	50 dia
Weight of Cover and frame	38 kg ------	116 or 208 kg	116 or 208 kg	116 or 208 kg

5.10.3 All manholes shall be provided with cement concrete benching in 1:2:4 mix. The benching shall have a slope of 10 cms towards the channel. The depth of the channel shall be full diameter of the pipe. Benching shall be finished with a floating coat of neat cement. (1 cement: 2 coarse sand: 4 stone aggregate 20 mm nom. Size) as per standard details.

5.10.4 All manholes shall be plastered with 12mm thick cement mortar 1: 3 (1 cement: 3 coarse sand) and finished with a floating coat of neat cement inside. Manhole shall be plastered outside as above but with rough plaster mixed with water proofing compound.

5.10.5 All manholes with depths greater than 1 m. shall be provided with 20 mm square or 25 mm round rods plastic coated catch rings set in cement concrete blocks

25x10x10 cms in 1:2:4 mix 30 cms vertically and staggered. Foot rests shall be coated with coal tar before embedding.

5.10.6 All manholes shall be provided with cast iron/steel fiber reinforced plastic (SFRC) covers and frames and embedded in reinforced cement concrete slab. Weight of cover, frame and thickness of slab shall be as specified in the Schedule of Quantities or given above.

5.10.7 Road gullies, ramp drains, gratings in basement shall be cast iron with M.S. frame or Steel Fiber Reinforced Concrete (SFRC) with frame as specified in the Schedule of Quantities.

5.11 Making connections

5.11.1 Contractor shall connect the sewer line of the building to the main manhole by providing making holes and channels etc.

5.12 Measurement

5.12.1 Excavation

5.12.1.1 Measurement for excavation of pipe trenches shall be made per linear meter under the respective category of soil classification encountered at site and specified in the tender.

A) Ordinary soil
B) Hard soil (hard moorum & soft rock)
C) Hard rock requiring chiseling
D) Hard rock requiring blasting

5.12.1.2 Trenches shall be measured between outside walls of manholes at top and the depth shall be the average depth between the two ends to the nearest cm. The rate quoted shall be for a depth up to 1.5 m or as given in the Schedule of Quantities.

5.12.1.3 Payment for trenches more than 1.5 m in depth shall be made for extra depth as given in the schedule of quantities and above the rate for depth up to 1.5 m.

5.12.1.4 Timbering and Shoring Timbering and shoring as described above shall be measured per sq m and paid for as per the type of timbering of shoring done at site and as per the relevant item in the Schedule of Quantities. Rate for timbering and shoring shall be for all depths and types of soil classifications including saturated soil.

5.12.1.5 Saturated Soil

No extra payment for pumping and bailing out water shall be made for excavation with an average depth of 1.5 m in saturated soil, surface water from rain falls or broken pipes lines, or sieves and other similar sources. An extra rate as quoted in the schedule of quantities shall be paid for excavation in saturated soil for pipe trenches above average depth of 1.5 m. No payment is admissible for water collected from surface sources and broken pipelines or sewers.

5.12.1.6 Refilling, Consolidation and Disposal of Surplus Earth

Rate quoted for excavation of trenches shall be inclusive of refilling, consolidation and disposal of surplus earth within a lead of 200 m.

5.12.2 Stoneware Pipes/RCC/C.I. pipes

Stoneware/R.C.C./C.I. pipes shall be measured for the finished length of the pipeline per linear meter i.e.

(a) Lengths between manholes shall be recorded from inside of one manhole to inside of other manhole

(b) Length between gully trap and manhole shall be recorded between socket of pipe near gully trap and inside of manhole. Rate shall include all items given in the schedule of quantities and specifications.

5.12.3 Gully Traps

Gully traps shall be measured by the number and rate shall include all excavation, foundation, concrete brick masonry, cement plaster inside and outside, C.I. grating and sealed cover and frame.

5.12.4 Cement Concrete for Pipes

Cement concrete in bed and all-round or in haunches shall be paid per running meter between the outside walls of manholes at bottom of the trench. No additional payment is admissible in respect of concreting done for widths greater than specified, for shuttering or centering and concreting in sub soil water conditions.

5.12.5 Manholes, Catch basins & Ramp drains

a) All manholes and catch basins shall be measured by numbers and shall include all items specified above and necessary excavation, refilling & disposal of surplus earth.

b) Manholes with depths greater than specified under the main item shall be paid for under "extra depth" and shall include all items as given for manholes. Measurement shall be done to the nearest cm. Depth of the manholes shall be measured from top of the manhole cover to bottom of chancel.

a) Ramp drains shall be measured per meter length.

5.12.6 Making Connections

Item for making connection to municipal sewer shall be paid for by number and shall include all items given in the Schedule of Quantities and specifications.

6.0 Garden Irrigation System

6.1 Scope of Work

Work under this section consists of furnishing all labour, materials equipment and appliances necessary and required to install garden hydrants and sprinklers and drip
Irrigation water supplies system as required by the drawings, specified hereinafter and as given in the Schedule of Quantities (BOQ).

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

a) Connections from the water supply system to all hydrants, sprinklers and drip irrigation points.

b) Garden hydrants, surface sprinklers & pipe emitters.

c) Excavation and refilling of pipes trenches.

d) Control valves, masonry chambers and other appurtenances.

e) Connections to all pumps & appliances.

6.2 The System

6.2.1 The garden hydrant and sprinkler irrigation system will be new and fully working system in the complex.

6.4.1 System components shall be pipes, valves, controllers, various types of sprinklers and drip irrigation lines with emitters as approved by the Project Manager.

6.5 **General requirements**

6.3.1 All materials shall be new of the best quality conforming to specifications. All works executed shall be to the satisfaction of the Project Manager.

6.5.1 Pipes and fittings shall be fixed truly vertical, horizontal or in slopes as required in a neat workmanlike manner.

6.5.2 Short or long bends shall be used on all main pipe lines as far as possible. Use of elbows shall be restricted fur short connections.

6.5.3 Pipes shall be laid in a manner as to provide as far as possible easy accessibility for repair and maintenance. Pipes under roads shall be laid in RCC pipe sleeves.

6.5.4 Valves and other appurtenances shall be so located as to provide easy accessibility for operations, maintenance and repairs.

6.6 **HDPE Pipes and Fittings.**

6.6.1 Garden hydrant mains shall be HDPE pipes conforming to IS: 4984 of class specified. If class is not mentioned in the schedule of quantities the same shall be Material Grade PF100, *unless other materials like uPVC schedule 40 or uPVC as per IS 4985 in accordance to specifications given above are specified in the BOQ*.

6.6.2 Fittings for HDPE pipes shall be injection molded fitting suitable for thermal weld joints. Fittings must have suitable provision for expansion and shall be rated for the same working pressure as the pipeline, *unless other materials like uPVC schedule 40 or uPVC as per IS 4985 in accordance to specifications given above are specified in the BOQ*.

6.6.3 Thermal Joints shall be made in an approved manner as recommended by the manufacturer.

6.6.4 Provide flanges at intervals of 20-25 m. for all pipes 65 mm dia and above.

6.6.5 Provide suitable adapters for connection between pipes & valves.

6.6.6 Provide cement concrete supports and anchor blocks at all bends, tees and other locations as directed by the Project Manager. Connections at garden hydrant outlet, near valves must also be anchored.

6.6.7 **Drip Irrigation Pipes**

Pipes shall be LLDPE pies of UC 7510 resin conforming to ASAE S-435 standard.

6.6.8 **G.I. Pipes & Fittings**

Vertical connection for garden hydrant points shall be galvanised steel tubes to IS12:1239 (medium class) with matching malleable iron fitting of approved make.

6.7 **Sprinklers**

Pop-up Sprinklers Pop-up sprinklers shall be underground with rugged plastic high impact case with precision jet spray guide arm control with brass head, Sprinklers shall be suitable for pressure and coverage given in the schedule of quantities.

PUMPING AND WATER TREATMENT PLANT SYSTEM

7.0 SCOPE OF WORK

a) Work under this section shall consist of furnishing all labour, materials equipment and appliances necessary and required to completely install all works described hereinafter and shown on the drawings.

b) Without restricting to the generality of the foregoing the system shall include the following:

a. Raw water, Treated water, Soft water and drainage pumps.

b. Water filtration plant with pressure filter and chlorination plant.

c. Water Softening plant.

7.1 GENERAL REQUIREMENT

7.1.1 All materials shall be new as per approved makes complying with the appropriate Indian Standards.

7.1.2 All equipment other than specified in approved makes shall be of the best available make manufactured by reputed firms to the entire satisfaction of Resident Engineer.

7.1.3 The sample of the items shall be provided on the request of engineer-in-charge.

7.1.4 All equipment shall be so installed on suitable existing foundations, true to level and in a neat work- man like manner.

7.1.5 Equipment shall be installed so as to provide sufficient clearance between the end walls & between equipment to equipment.

7.1.6 Shop drawings for equipment layout with associated piping, control panels and wiring of equipment showing the route of conduit / cable from equipment to control panel shall be submitted by the Contractor for approval to engineer-in-charge before starting the fabrication of panel and starting the work. On completion of the works, four sets of "As-installed" drawings incorporating all details like equipment layout, piping routes, location of panels etc. shall be furnished by the contractor.

7.2 WATER SUPPLY PUMPS

7.2.1 Domestic Water Supply

Domestic water transfer pumps shall be single stage, vertical stainless-steel pumps, having stainless steel casing, stainless steel pump foot and diffusers, stainless impeller, stainless steel shaft, ceramic bearings, tungsten carbide shaft protection bushes and mechanical seal driven 2900 RPM, 220 Volts, 50 Cycles, AC 3 –phase TEFC vertical flange motor. Each pump shall be capable of operating within a performance pressure characteristics range sufficient below and above the required working pressure.
Pumps and motors shall be mounts on a common MS structural base plate.

Each pumping set shall be providing with a Gun Metal “Bourden” type pressure gauge with gunmetal isolation cock and connecting piping and also with pressure switch for its operation controlling.

Appropriate vibration eliminating pads shall be provides with each pump.

The pump set shall be provided with gun metal gate valve of appropriate sizes on

delivery. a non-return valve of appropriate size and a pressure gauge with cock shall be provided on the delivery line.

Suction and delivery lines of the pumps shall be provided with double flanged reinforced Neoprene flexible pipe connectors. Connectors shall be suitable for a working pressure of each pump as specified in Schedule of Quantities.

Mega Control Device with one number variable frequency drive.

7.2 WATER TREATMENT PLANT FEED PUMPS

Treatment plant feed pumps shall be single stage, vertical stainless-steel pumps, having stainless steel casing, stainless steel pump foot and diffusers, stainless impeller, stainless steel shaft, ceramic bearings, tungsten carbide shaft protection bushes and mechanical seal driven 2900 RPM, 220 Volts, 50 Cycles, AC 3 –phase TEFC vertical flange motor. Each pump shall be capable of operating within a performance pressure characteristics range sufficient below and above the required working pressure.

Pumps and motors shall be mounts on a common MS structural base plate.

Each pump shall be providing with a totally enclosed fan cooled induction motor of H.P and R.P.M specified in schedule of quantities.

Each pump shall be providing with a Gun Metal “Bourden” type pressure gauge with gunmetal isolation cock and connecting piping.

Appropriate vibration eliminating pads shall be provides with each pump.

The pump set shall be provided with gun metal gate valve of appropriate sizes on delivery. a non-return valve of appropriate size and a pressure gauge with cock shall be provided on the delivery line along with suitable size of Y- strainer at suction side.

Suction and delivery lines of the pumps shall be provided with double flanged reinforced Neoprene flexible pipe connectors. Connectors shall be suitable for a working pressure of each pump as specified in Schedule of Quantities.

7.3 SUMP PUMPS

Pumps shall be submersible type as indicated in data sheet.

Pump shall be integral with submersible motor on a common shaft. The pumps shall have 2900 rpm synchronous speed unless stated otherwise in the data sheets.

The pump set shall be installed in vertical position in sumps with level controller cum operated float switches.

Pump casings shall be aluminum and impellers of SS. All pumps shall have combination ball and roller bearings and shaft seals should be mechanical. Motor shall be submersible and shall be rated for minimum hp specified or the BHP absorbed in the operating range of the pump.

7.4 DOSING PUMP

Dosing Pump shall be provided for the working pressure of System where the solution is to be dosed.

Metering Pump shall be provided for operation on 220 V, 50 Hz., AC Power Supply.

Piping from the Main Water Supply Line to the doser shall be PVC flexible pipe branded.

All parts of the metering/dosing pump coming in contact with solution shall be of stainless steel of grade SS-304.

7.5 LEVEL CONTROLLER

Contractor shall provide and install low voltage transistorized level controllers as specified in Schedule of Quantities. Each level controller shall be provided with required number of PVC sheathed stainless steel probes with necessary wiring and conducting.

7.6.1 FOR FILTER FEED PUMPS

To cut off water treatment plant feed pumps on low water level in raw water tanks and high water level in ground floor treated water tank. To start pumps on low water level in treated water tanks.

7.6.2 FOR SOFTENER FEED PUMPS

To cut off water treatment plant feed pumps on low water level in Treated water tanks and high-water level in ground floor Soft water tank. To start pumps on low water level in soft water tanks.

7.6.3 TREATED WATER TRANSFER PUMPS

To cut off treated water transfer pumps on low water level in treated water tank and high-water level in overhead treated water tank and start sump on low water level in overhead treated water tank.

7.6.4 IRRIGATION WATER TRANSFER PUMPS

To cut off soft water transfer pumps on low water level in soft water tank and high-water level in overhead soft water tank and start sump on low water level in overhead soft water tank.

7.6.5 FOR HYDROPNEUMATIC SYSTEM

To cut off hydro-pneumatic system pumps on low water level in ground level treated water tanks. To start pumps on opening of any taps.

7.7 WATER FILTERATION & SOFTENING PLANT

The water treatment equipment shall be based on the raw water criteria as mentioned.

S.No.	Parameters	Raw Water (Inlet) Properties of water	Unit	Desirable Limits Drinking Water as per IS 10500	Extended Limits Drinking Water as per IS 10500
1	Colour	< 1	Max	5	
2	Turbidity	0.2	NTU	5	
3	PH Valve	7.6	Range	6.5 – 8.5	
4	Total Dissolved Solid	800	Mg/l		2000
5	Chlorides (as Cl)	180	Mg/l	250	1000
6	Sulphate as SO4	190	Mg/l		400
7	Fluorides(as F)	0.2	Mg/l	1	1

8	Magnesium as Mg	3.1	Mg/l		
9	Total Hardness, CaCO3	267	Mg/l		

7.7.1 WATER FILTERS

Water filters shall be sand / gravel pressure filters downward or upward flow type suitable for a rate of filtration given in schedule of quantities.

Filter shall be vertical type of required diameter. The shell shall be fabricated from M.S. plate suitable to withstand a working pressure given in schedule of quantities. The minimum thickness of shall will be 8 mm and dished ends shall be 10 mm. The filter shall have at least one pressure tight manhole cover. Each filter shall be provide with screwed or flanged connections for inlet, outlet individual drain connections and all other connections necessary and required. Filter shall be painted inside with two or more coats of non- toxic corrosion resistant paint and one coat of red oxide primer outside.

UNDER DRAIN SYSTEM: Each filter shall be provides with an efficient under drain system comprising of collecting pipes, gunmetal / poly propylene nozzles of manufacturer's design. The entire under drain system shall be provides on M.S. plate cement concrete supports.

FACE PIPING: Each filter shall be provides with interconnecting face piping comprising of inlet, outlet, and backwash complete with valves. Piping shall be cast iron double flanged to I.S.1536-1967 and C.I. Double flanged fittings to I.S. 1537-1967. Sluice valves 65 mm dia. and above shall be cast iron Double flanged sluice valves to I.S. 780. Valves 50 mm and below shall be screwed type gunmetal full way gate valves. Water softener must be of multiport valve.

ACCESSORIES: Each filter shall be provided with following accessories:

Air release valve with connecting piping.

100 mm diameter dial Bourden type gunmetal pressure gauges with gunmetal isolation cock and connecting pipes.

Sampling cocks on raw water inlet and filtered water outlet.

Individual drain connection with gunmetal full way valve.

Connection with valve for air scouring.

Flow meter or water meter (if required).

FILTER MEDIA

Each filter shall be provided with clean and washed filter media. Following is recommended:

Pebbles	13.6mmsize	(100mm deep)
Gravel	6-2.5mmsize	(100mm deep)
Coarse sand	2.5-.25mm size	(100 mm deep)
Fine sand	1.25-.08mm size	(650-750mm deep)
Activated		600mm

The above filter media arrangement may be altered to suit contractor's own design for the most efficient performance.

7.7.2 CHEMICAL DOSER (Alum Doser, chlorinator)

Chemical doser shall be displacement type complete with rubber bag in vessel duly painted of 50 liters capacity or as mentioned in the schedule of quantities.

Doser shall be suitable for working pressure mentioned in the schedule quantities.

Each doser shall be provided with orifice plate assembly injection and corrosion proof piping. Piping from the main water supply line to the doser shall be G. I. pipes to IS : 1239 (heavy class).

7.7.3 WATER SOFTNER

Softener vessel shall be designed in accordance with the code of unfired pressure vessel conforming to BIS.

Softeners shall be designed to give 'Soft Water' of quality of Commercial Zero i.e. hardness less than 5 ppm for soft water tanks and less than 150 ppm for treated water tank. Softener shall provide with suitable grade of CATION exchange resin in quantity to be considered by the Contractor at the time of quoting.

Softener shall be fabricated out of mild steel and suitable for self-supporting arrangement.

Softener shall have a set of face piping for inlet, outlet brine injection with all valves. Suitable drain shall be provided (with multiport valve preferably).

One set of hydraulic injectors with control valve and brine delivery pipes.

One cylindrical PVC/HDPE brine saturator and mixing tank, provided with brine delivery piping with adjustable level indicating clamp and control valves complete. The tank shall be of capacity as given in the schedule of quantities.

The first charge of resin, chemicals, media & consumables shall be included in the cost of water softening plant.

7.9 **INSTALLATION AND TESTING**

All pumps, water treatment equipments, R.O. plants and solar heater shall be laid out generally in accordance with the shop drawings (submitted by contractor and approved by engineer-in-charge / consultant / architect) achieving economy of space and piping.

All pumps, water treatment equipments, R.O. plants and solar heater shall be tested for the rated performance in the presence of the employer's representative and got approved.

7.10 **Mode of measurement**

Pumps for water supply with valves on suction & delivery side, non-return valve on delivery, pressure gauge on delivery, set of high/low control including wiring, foundation bolts, nuts etc. shall be measured as one unit and paid.

Sump pumps with motor, water proof cable, gun metal valve, and non-return valve in delivery all installed in position will be measured as one unit and paid.

Level controllers shall be measured by numbers.
Water filter, Softener, Chemical dosers shall be measured by number and shall include all items given in schedule of quantities.

7.11 **CATALOGUES & MANUAL**

The Contractor shall furnish the operation & maintenance manual/ technical literatures in duplicate to engineer-in-charge.

B. TECHNICAL SPECIFICATIONS FOR ELECTRICAL WORKS

ELECTRICAL WORK

1.0 Scope

1.1 The scope of this section comprises of fabrication, supply, erection, testing and commissioning of electric panels, wiring and earthing of all equipment components and accessories, including supply, installation and wiring of remote mounted push button stations.

1.2 All the electrical cables, termination, wires and accessories are also including in the Scope of Work. The main cable from the main distribution board will be supplied and erected by other Agency.

2.0 General

2.1 Work shall be carried out in accordance with the specifications of CPWD specifications, Indian Electricity Act 1910 and Indian Electricity Rules 1956 as amended up to date.

3.0 Construction Features

3.1 The control panel shall be metal enclosed sheet steel cubical, indoor type, floor mounting/wall mounting type as per BS 5486 Part 1, 190 & IEC 439-1. The control panel shall be totally enclosed, completely dust and vermin proof, Gaskets between all adjacent units and beneath, covers shall be provided to render the joints dust proof. Control panels shall be arranged in multitier formations. All doors and covers shall also have sealing & pad locking arrangement. All mild steel sheets used in the construction of control panels shall be minimum 2mm. thick or as specified 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 slag grounded off and welding pits wiped smooth with plumber metal.

3.2 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 provided with hank nuts. Self threading screws shall not be used in the construction of control panels. Base channel shall be of 75mm x 40mm x 5mm thick shall be provided at the bottom. Minimum clear space of 250 mm between top of channel of control panel and bottom most unit shall be provided.

3.3 The control panels shall be of adequate size with a provision of 10% spare space to accommodate possible future additional switchgear. Knockout holes of appropriate size and number of cables 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 both above and below the control panel. Where cables enter below, cables boxes shall be fitted at the rear and arranged in tiers to facilitate making connections to the upper and lower units. Clamps shall be provided to support the weight of the cables. All incoming and outgoing feeders shall be brought out to a terminal block of adequate size at suitable location inside the control panel. All wiring inside the control panel shall be color coded and labeled with approved plastic beads for identification. Circuit diagrams showing the arrangement of circuits shall be pasted on the inside of the panel door and covered with transparent plastic sheet and all labeling shall be provided on the front face of the panel board.

4.0 Circuit Compartments

4.1 Each circuit breaker, contactor and relay shall be housed in a separate compartment and shall be enclosed on all sides. 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 the draw out position of the panel. Instruments and indicating lamps shall not be mounted on the panel compartment door. Sheet steel barriers shall be provided between the tiers in a vertical section.

5.0 Instrument Accommodation

5.1 Separate and adequate compartments shall be provided to accommodate instruments, indicating lamps, control contactors and control fuses etc. These shall be accessible for testing and maintenance without any danger of accident contact with live parts of the circuit breaker and bus bar.

6.0 Bus Bars and Bus bar Connection

6.1 The bus bar and interconnections shall be of aluminum and of rectangular cross sections suitable for full load current for phase bus bars and half rated current for neutral bus bars and shall be extensible on either side. The bars and inter-connections shall be insulated with PVC heat shrinkable sleeve and color coded. All bus bars shall be supported on unbreakable, non-hygroscopic insulated SMC/DMC type supports at regular intervals not more than 400 mm, to withstand the forces arising in case of short circuit in the system. Bus bars shall be provided in separate chamber of main control panels shall be connected by clamping, no holes shall be drilled in bus bars. If holes have to be drilled for making connections, extra cross section of bus bars shall be provided.

6.2 All bus bar connections in smaller control panels shall be done by drilling hole and connecting by brass bolts and nuts. Additional cross section of bus bars shall be provided in small control panels to cover up the holes drilled in the bus bars.

6.3 All connections between the bus bar and breaker and between breaker and contactor shall be through copper strips of proper size to carry full rated current and shall be insulated with coloured PVC heat shrinkable sleeve.

7.0 Terminals

7.1 The outgoing terminals and neutral links shall be brought out to a terminal block suitably located in the control panels. The current transformer for instruments, metering and for protection shall be mounted on the terminal blocks. Separate cable compartment shall be provided for incoming and outgoing cables.

8.0 Wire ways

8.1 A horizontal wire way screwed covers shall be provided at the top to take in the connecting control wiring of different vertical sections.

9.0 Cable Compartments

9.1 Cable compartments/alley of adequate size shall be provided in the control panels for easy termination of all incoming and outgoing cables entering from bottom or top using detachable gland plates with proper knockouts. Adequate and proper DMC supports shall be provided in cable compartments to support cables. All incoming and outgoing terminals shall be brought out on terminal blocks in the cable compartment.

10.0 Materials

a) Rotary Switches

Switches up to 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. The terminals shall be shrouded with insulation to prevent accidental contact with live parts. Rotary switches shall be backed up with moulded type HRC fuse fittings of appropriate rating.

b) Selector Switch

When called for, selector switches of rated capacity shall be provided in control panels, to give the choice of operating equipment in selective mode.

c) Molded Case Circuit Breakers (MCCB)

MCCBs shall be quick make, quick break and preferably double break contact system, arc extinguishing device, independent manual type with trip free feature with mechanical ON, OFF, and TRIP indications as called for in BOQ. A trip button shall be provided for tripping the breaker.

MCCB shall be a compact high strength, heat resistant, flame retardant; insulating molded case with high withstands capability against thermal and mechanical stresses. All MCCBs shall be capable of defined variable overload adjustment

d) Switches

Switches beyond 60 amps shall be panel mounted double break type and suitable for load break duty, quick make and break action. Switch contacts shall be silver plated and shall be back-up with HRC fuses of appropriate rating. The switch handles shall be located at the front.

e) HRC Fuses

Fuses shall be high Rupturing capacity of not less than 20 MVA at 415 volts. The backup fuse rating of each motor/heater/equipment shall be so chosen that the fuse does not operate on starting of motor/heater/equipment. Fuses shall be of the same make as the switches.

f) Starters

Each motor shall be provided with a starter of suitable rating. Direct on-line starters shall be provided for motors up to 10 HP.

Operating coils of contactors shall be suit able for 220/415 $\pm$ 10% volts AC, 50 cycles supply system. The contactor shall drip out when voltage drops to 90% of the rated voltage.

g) Over Load Relays

Contactors shall be provided with a three element, positive acting ambient temperature compensated time lagged hand-reset type thermal over load relay with adjustable setting.

h) Current Transformers

Current Transformer shall be of accuracy class - I and suitable VA burden for operation for the connected meters and relays.

i) Single Phase Preventor

Single phase preventor shall be provided for all the starters. Single phase preventor shall act when the supply voltage drops down to 90% of the rated voltage or on failure of one or more phases.

j) Indicating Lamp and Metering

The meters shall be flush mounted and draw-out type. The indicating lamp shall be neon type and of low burden. Each phase indicating lamp shall be backed up with 2 amps fuse.

k) Push Button Stations

Push button station shall be for manual starting and stopping of motors/equipment as called for. Red and Green colour push buttons shall be provided for starting and stopping operations. Push buttons shall be suitable for panel mounting and accessible from front without opening door.

m) Cables

M.V. cables shall be PVC insulated aluminum conductor armoured cables suitable for laying in trenches, duct, and on cable trays as required.

n) Wires

650/1100 volts grade PVC insulated copper conductor wires in conduit shall be used.

11.0 Cable Laying

11.1 Easy 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 minimize the loss in current carrying capacity with necessary saddling/clamps.

12.0 Earthing

12.1 The earthing of MCC and equipment shall be as per BIS Specification and considered in the main electrical panel. The loop earthing shall be carried out with G.I/Copper Strips/wires.

13.0 Painting for Panel

13.1 All sheet steel work shall undergo a process of seven tank treatment and painting with powder coating paint of approved shade.

14.0 CABLE WORK

This section covers detailed requirements for supply, laying, testing and commissioning of cables.

14.1 GENERAL

MV cable 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 drum.

14.2 **MATERIAL**

14.2.1 The MV power cable of 660/1100 V. grade shall be PVC insulated Aluminum conductor armored cable conforming to IS: 1554 (part - I). MV cable shall be 3.5/4 core of size and type as specified.

14.2.2 The MV control cables shall be PVC insulated copper conductor armored cable.

14.3 STORAGE AND HANDLING

14.3.1 All cables shall be inspected upon receipt at site and checked for any damage during transit.

14.3.2 Cable drums shall be stored on a well drained, hard surface, preferably of concrete, so that the drums do not sink in the ground causing rot and damage to the cable drums.

14.3.3 During storage periodical rolling of drums once in 3 months through 90^{o} shall be done. Rolling shall be done in the direction of the arrow marked on the drum.

14.3.4 It should be ensured that both ends of the cable are properly sealed to prevent ingress/absorption of moisture by the insulation.

14.3.5 Protection from rain and sun shall be ensured. Sufficient ventilation between cable drums, should be ensured during storage.

14.3.6 The drums shall always be rested on the flanges and not on the flat sides.

14.3.7 Damaged battens of drums etc. should be replaced, if necessary.

14.3.8 When cable drums have to be moved over short distances, they should be rolled in the direction of the arrow, marked on the drum.

14.3.9 For transportation over long distances, the drum should be mounted on cable drum wheels strong enough to carry the weight of the drum and pulled by means of ropes. Alternatively, they may be mounted on a trailer or on a suitable mechanical transport.

14.3.10 When unloading cable drums from vehicles, a crane shall preferably be used. Otherwise the drum shall be rolled down carefully on a suitable ramp or rails, where necessary.

14.3.11 While transferring cable from one drum to another, the barrel of the new drum shall have a diameter not less than that of the original drum.

14.3.12 The cables shall not be bent sharp to a small radius. The minimum safe bending radius for all types of PVC cables shall be taken as 12 times the overall diameter of the cable. Wherever practicable, larger radius should be adopted. At joints and terminations, the bending radius of individual cores of a multi core cable shall not be less than 15 times its overall diameter.

14.3.13 Cable with kinks and straightened kinks or with similar apparent defects like defective armouring etc. shall be rejected.

14.3.14 Cables from the stores shall be supplied by the contractor as per the site requirement in pieces cut in the stores.

14.4 INSTALLATION

14.4.1 GENERAL

The cable installation including necessary joints shall be carried out in accordance with the specifications given herein. For details not covered in these specifications, I.S.:1255 shall be followed. No straight through joint shall be permitted in the system. The cables shall be supplied as per cable schedule submitted by the contractor & approved by Engineer-in-Charge.

14.4.2 ROUTE

14.4.2.1 Before the cable laying work is undertaken, the route of the cable shall be decided by the Architect in consultation with Owner representative.

14.4.2.2 While shortest practicable route shall be preferred, cable runs shall generally follow fixed developments such as roads, foot-paths etc. with proper

offsets so that future maintenance, identification etc. are rendered easy. Cross country run to shorten the route length is not desirable as it would lead to route identification and maintenance problems, besides posing difficulties during later development of open areas etc.

14.4.2.3 While selecting cable routes, corrosive soils, ground surrounding sewage and effluent etc. shall be avoided. Where this is not feasible, special precautions as approved by the Architect shall be taken.

14.4.2.4 As far as possible, the alignment of the cable route shall be decided taking into consideration the present and future requirements of other agencies and utility services affected by it, the existence of any cable in the vicinity as may be indicated by cable markers or cable schedules or drawing maintained for that area, possibilities of widening of roads/lanes, storm water drains etc. Cable routes shall be planned away from the drains and should be within the property.

14.4.2.5 Whenever cables are laid along well demarcated or established roads, the MV cables shall be laid further from the kerb line than HV cables.

14.4.2.6 Cables of different voltages and also power and control cables shall be kept in different trenches with adequate separation. Where available space is restricted, MV cables shall be laid above HV cables.

14.4.2.7 Where cables cross one another the cable of higher voltage shall be laid at a lower level than the cable of lower voltage.

14.5 **WAY LEAVE**

14.5.1 It may be necessary to obtain way leave for the cable route from the appropriate authorities some of whom are listed below:

a) Drainage, Public Health and Water Works.
b) Telephones and Telegraphs.
c) Gas works.
d) Other Undertakings.
e) Owners of properties.

14.5.2 Where necessary, joint inspection with representatives of other authorities may be arranged so that mutual interests are safeguarded. In case of private property, Section 12/51 of the Indian Electricity Act shall be complied with.

14.6 PROXIMITY TO COMMUNICATION CABLES

Power and communication cables shall as far possible cross at right angles. Where power cables are laid in proximity communication cables the horizontal and vertical clearances shall not normally be less than 60 cms.

14.6.1 **LAYING METHODS**

14.6.1.1 Cables shall be laid direct in ground or in pipes/closed ducts, in open ducts or on cable trays suspended from slab depending on site conditions.

14.6.2 **Laying in Pipes/Closed ducts:**

14.6.2.1 In location such as road crossing, entry to building, on poles, in paved areas etc. cables shall be laid in pipes or closed ducts.

14.6.2.2 GI or Hume Pipes (spun reinforced concrete pipes) shall be used for such purposes. In the case of new construction, pipes as required shall be laid along with the Civil works and jointed according to the instructions of the Engineer-in-Charge as the case may be. The size of pipe shall be as indicated in the electrical drawings. GI pipe shall be laid directly in ground without any special bed. Hume pipe (Spun reinforced concrete pipe) shall be laid over 10 cm. thick cement concrete 1:5:10 (1 cement : 5 coarse sand : 10 graded stone aggregate

of 40mm nominal size) bed, after which it shall be completely embedded in concrete. No sand cushioning or tiles need be used in such situations. Unless otherwise specified, the top surface of pipes shall be at a minimum depth of 1mtr. from the ground level when laid under roads, pavement etc.

14.6.2.3 Where steel pipes are employed for protection of single core cables feeding AC load, the pipe should be large enough to contain both cables in the case of single phase system and all cables in the case of polyphase system.

14.6.2.4 The pipes on road crossing shall preferably be on the skew to reduce the angle of bends as the cable enters and leaves the crossings. This is particularly important for high voltage cables.

14.6.2.5 Manholes of adequate size as decided by the Engineer-in-Charge shall be provided to facilitate feeding/drawing in of cables and to provide working space for persons. They shall be covered by suitable manhole covers with frame of proper design. The construction of manholes and providing the cover is not in the scope of this Contract and shall be got executed and paid for by the Engineer-in-Charge through another agency.

14.6.2.6 Pipes shall be continuous and clear of debris or concrete before cable is drawn. Sharp edges at ends shall be smoothened to prevent injury to cable insulation or sheathing.

14.6.2.7 Pipes for cable entries to the building shall slope downwards from the building and suitably sealed to prevent entry of water inside the building. Further the mouth of the pipes at the building end shall be suitably sealed to avoid entry of water. This seal in addition to being waterproof shall also be fireproof.

14.6.2.8 All chases and passages necessary for lying of service cable connections to buildings shall be cut as required and made good to the original finish and to the satisfaction of the Engineer-in-Charge.

14.6.2.9 Cable grips/draw wires and winches etc. may be employed for drawing cables through pipes/closed ducts etc.

14.6.3 **Laying on Cable Trays**

14.6.3.1 Cables, where indicated in approved shop drawings, shall be laid on overhead cable trays which are suspended from ceiling or supported from wall, by anchor fasteners as required.

14.6.3.2 The Contractor shall provided for all accessories for the installation of the cable trays, such as bends, tees, reducers coupler plates, trifoil clamps and structural steel members (comprising of channels, angles, flats, rods) to be fabricated at site for structural supports for cable trays racks etc.

14.6.4 **Termination**

Brass single compression glands shall be provided for MV cables termination

14.6.5 **Testing**

14.6.5.1 All 650/1100 Volt grade cables before laying shall be tested with a 500 V megger or with a 2,500/5,000 V megger for cables of higher voltages. The cable cores shall be tested for continuity, absence of cross phasing, insulation resistance to earth/sheath/armour and insulation resistance between conductors.

14.6.5.2 All cables shall be subject to above mentioned tests during laying, before covering the cables by protective covers and back filling and also before the jointing operations.

15.0 CABLE TRAYS

15.1 Prefabricated Cable trays of ladder type and associated accessories, tees, bends, elbows & reducers shall be fabricated from 12 gauge (2.6 mm thick) mild steel. Perforated cable trays and associated accessories tees, elbows, and reducers shall be fabricated from 14 gauge (2 mm thick) MS steel.

15.2 Cable trays and accessories and covers shall be painted with one shop coat of red oxide zinc chromate primer and two coats of Aluminum alkyd paint.

15.3 The Contractor shall provide for all accessories for the installation of the cable trays, such as bends, tees, reducers coupler plates, trifoil clamps and structural steel members (comprising of channels, angles, flats, rods) to be fabricated at site for structural supports for cable trays racks etc.

16.0 EARTHING

This section covers detailed requirements for earthing.

16.1 GENERAL

16.1.1 The non-current carrying metal parts of electrical installation shall be earthed properly. All metallic structure, enclosures, junction boxes, outlet boxes, cabinets, machine frame, portable equipments, metal conduits, trucking, cable armor, switchgear, distribution boards, lighting fittings and all other parts made of metal in close proximity with electrical circuits shall be bonded together and connected by means of specified earthing conductors to an efficient earthing system. All earthing will be in conformity with the relevant Indian Electricity Rules 1956 and Indian Standard Specification IS: 3043. Every item of equipment served by the electrical system shall be bonded to earthing system.

16.1.2 Every switch, lighting fixture and 5 Amp outlets shall be provided with insulated copper conductor of 1.5 sq. mm for earthing. The computer workstations shall be earthed with 2.5 sq.mm. insulated copper conductor wire.

16.1.3 Separate copper earth pits shall be provided for UPS, EPABX & Networking equipment.

16.1.4 The raceways shall not be used as a grounding conductor.

16.2 CONNECTION OF EARTHING CONDUCTORS

16.2.1 Main earthing conductor shall be taken from the earth connections at the PDB to the earthing pit. Circuit earthing conductor shall run from the exposed metal of equipment and shall be connected to any point on the main earthing conductor, or its distribution boards or to an earth leakage circuit breaker. Metal conduits, cable sheathing and armouring shall be earthed at the ends adjacent to switch boards at which they originate, or otherwise at the commencement of the run by an earthing conductor in effective electrical contact with cable sheathing. Where equipment is connected by flexible cord, all exposed metal parts of equipment shall be earthed with 2 no. G.I. strips/wires and non-current carrying metallic parts with, 1 no. G.I. strips/wires.

16.2.2 Neutral conductor, sprinkler pipes, or pipes conveying gas, water or inflammable liquid, structural steel work, metallic enclosures cables and conductors, metallic conduits and lightning protection system conductors shall not be used as a means of earthing an installation or even as a link in earthing system. The Electrical resistance of metallic enclosures for cables and conductors measured between earth connections at the main switch boards and any other point on the completed installation shall be low enough to permit the passage of current necessary to operate circuit breakers and shall not exceed 1 OHM.

16.3 EARTH CONNECTIONS

All metal clad switches and other equipment carrying single phase circuit, shall be connected to earth by a single connection. All metal clad switches carrying 3 phases shall be connected with earth by two separate and distinct connections. The earthing conductor inside the building wherever exposed shall be properly protected from mechanical injury by running the same in GI pipe of adequate size. The earthing conductor shall be painted to protect it against corrosion. Earthing conductor outside the building shall be laid 600 mm below finished ground level. The over lapping in **G.I.** strips in joints shall be welded. Lugs of adequate capacity and size shall be used for all termination of conductor wires. Lugs shall be bolted to the equipment body to be earthed after the metal is cleaned of paint and other oily substance and properly tinned.

16.4 PROTECTION FROM CORROSION

Connection between copper and galavanised equipment shall be made on vertical face and protected with paint and grease. Galvanised fixing clamps shall not be used for fixing earth conductors. Only copper fixing clamp shall be used for fixing earth conductors. When there is evidence that the soil is aggressive to copper, buried earthing conductors shall be protected by suitable serving and sheathing.

16.5 EARTHING STATION

16.5.1 PLATE ELECTRODE EARTHING

16.5.1.1 Earthing electrode shall consist of a Copper plate of 600 mm X 600 mm X 3 mm or G.I. plate of 600mm x 600mm x 6.3 mm as called for in the Schedule of Quantity. The plate electrode shall be buried as far as practicable below permanent moisture level but in any case, not less than 3 meters below ground level. Wherever possible, earth electrode shall be located as near the water tap, water drain or a down take pipe as possible. Earth electrode shall be kept clear of the building foundations and in no case shall it be nearer than 2 meters from the outer surface of the wall.

16.5.1.2 The earth plate shall be set vertically and surrounded with 150 mm thick layer of charcoal dust and salt mixture. A 20 mm dia GI pipe shall run from the top edge of the plate to the ground level. The top of the pipe shall be provided with a funnel and a mesh for watering the earth through the pipe. The funnel over the GI pipe shall be housed in a masonry chamber approximately 300 mm x 300 mm x 300 mm deep. The masonry chamber shall be provided with a cast iron cover resting over a CI frame. Test facility shall be provided with test links for the earthing station.

16.5.2 PIPE ELECTRODE EARTHING

Earthing Electrode shall consist of G.I. medium class. 40 mm dia 4.5 m long pipe (without any joint) G.I. pipe Electrode shall be cut, tapered at the bottom and provided with holes of 12 mm dia drilled not, less than 7.5 cm from each other upto 2 M of length from the bottom. Pipe electrode shall be buried in the ground vertically with its top at not less than 200 mm below the ground level. When more than one pipe is to be installed a separation of not less than 2 M shall be maintained between two adjacent electrodes as called for in the drawings. Wherever possible, earth electrode shall be located as near the water tap, water drain or a down take pipe as possible. Earth electrode shall be kept clear of the building foundations and in no case shall it be nearer than 2 meters from the outer surface of the walls. The pipe electrode shall be set vertically and surrounded with 150 mm thick layer of charcoal dust and salt mixture. A 40 mm x 20 mm reducer shall be used for fixing of funnel with mesh. The funnel and mesh have been provided for watering the earth through the pipe. The funnel over the G.I. Pipe shall be housed in a masonry chamber 300mm x 300mm x 300mm. deep. The masonry chamber shall be provided with a cast iron cover resting over a CI frame. The breaked earth pit will be provided with test links in suitable enclosures.

16.5.3 ARTIFICIAL TREATMENT OF SOIL

If the earth resistance is too high and the multiple electrode earthing does not give adequate low resistance to earth, as specified in Clause no. 7 then the soil resistivity immediately surrounding the earth electrodes shall be reduced by adding sodium chloride, Calcium chloride, sodium carbonate, copper sulphate, salt and soft coke or charcoal in suitable proportions.

16.5.4 **RESISTANCE TO EARTH**

The resistance to each earthing system shall not exceed 1.0 ohm.

COMMISSIONING & GUARANTEE

1. SCOPE OF WORK

Work under this section shall be executed without any additional cost. The rates quoted in this tender shall be inclusive of the works given in this section.

Contractor shall provide all tools, equipment, metering and testing devices required for the purpose.

On award of work, Contractor shall submit a detailed proposal giving methods of testing and gauging the performance of the equipment to be supplied and installed under this contract.

All tests shall be made in the presence of the Architect or his representative or any inspecting authority. At least five working days notice in writing shall be given to the inspecting parties before performing any test.

Water flow rates of all equipment and in pipe lines through valves shall be adjusted to design conditions. Complete results of adjustments shall be recorded and submitted.

Contractor shall ensure proper balancing of the hydraulic system and for the pipes / valves installed in his scope of work by regulating the flow rates in the pipe line by valve operation. The contractor shall also provide permanent Tee connection (with plug) in water supply lines for ease of installing pressure gauge, temperature gauge & rotameters. Contractor shall also supply all required pressure gauge, temperature gauge & rotameter for system commissioning and balancing. The balancing shall be to the satisfaction of Consultant / Project Manager.

Three copies of all test results shall be submitted to the Engineer in A4 size sheet paper within two weeks after completion of the tests.

2 PRECOMMISSIONNIG

On completion of the installation of all pumps, piping, valves, pipe connections, insulation etc. the Contractor shall proceed as follows:

2.1 Prior to start-up and hydraulic testing, the Contractor shall clean the entire installation including all fitments and pipe work and the like after installation and keep them in a new condition. All pumping systems shall be flushed and drained at least once through to get rid of contaminating materials. All pipes shall be rodded to ensure clearance of debris, cleaning and flushing shall be carried out in sections as the installation becomes completed.

a) All strainers shall be inspected and cleaned out or replaced.

b) Check all clamps, supports and hangers provided for the pipes.

c) Check all the equipment, piping and valves coming under hot water system and operate each and every valve on the system to see if the

valves are functioning properly. Thereafter conduct & hydro test of the system as for (b) above.

d) Fill up pipes with water and apply hydrostatic pressure to the system as given in the relevant section of the specification. If any leakage is found, rectify the same and retest the pipes.

3 FINAL ACCEPTANCE TESTS

Following commissioning and inspection of the entire installation, and prior to issue of the Completion Certificate, the Contractor shall carry out final acceptance tests in accordance with a programme to be agreed with the Architect.

Should the results of the acceptance tests show that plant, systems and/or equipment fail to perform to the efficiencies or other performance figures as given in this Specification, the Contractor shall adjust, modify and if necessary replace the equipment without further payment in order that the required performance is obtained.

Where acceptance tests are required by the relevant Authorities having jurisdiction, these tests shall be carried out by the Contractor prior to the issue of Completion Certificate to the acceptance of the Authorities.

4 REJECTIONS OF INSTALLATION / PLANT

Any item of plant or system or component which fails to comply with the requirements of this Specification in any respect whatsoever at any stage of manufacture, test, erection or on completion at site may be rejected by the Architect either in whole or in part as he considers necessary/appropriate. Adjustment and/or modification work as required by the Architect so as to comply with the Authority's requirements and the intent of the Specification shall be carried out by the Contractor at his own expense and to the satisfaction of the Authority/Architect.

After works have been accepted, the Contractor may be required to carry out assist in carrying out additional performance tests as reasonably required by the Architect/Employer.

5. WARRANTY AND HANDOVER

The Contractor shall warrant that all plant, materials and equipment supplied and all workmanship performed by him to be free from defects of whatsoever nature before handover to the Owner.

6. HANDING OVER OF DOCUMENTS

All testing and commissioning shall be done by the Contractor to the entire satisfaction of the Owner’s site representative and all testing and commissioning documents shall be handed over to the Owner’s site representative.

The Contractor shall also hand over all maintenance and operation manuals, all certificates and all other documentation as per the terms of the contract to the Owner’s site representative.

8. PIPE COLOUR CODE:

S.No.	Pipe Lines	Ground / Base Color	First Color Band	Second Color Band
1	Drinking Water (All cold water lines after filter)	Sea Green	French Blue	Single Red
2	Treated Water (Soft Water)	Sea Green	Light Orange	

3	Domestic Hot Water	Sea Green	Light Grey
4	Drainage	Black	

Color code to confirm to IS: 2379:1990

LIST OF STANDARD CODES

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S.No.	**IS Code No.**	
1.	IS:1729:1979	Specification for sand cast iron spigot and socket soil, waste and ventilating pipes, fittings and accessories (1st rev.) (Amendment 4)
2.	IS:651:1992	Specification for salt glazed stoneware pipes and fittings (5th rev.) (Amendment 1)
3.	IS:456:1978	Code of practice for plain and reinforced concrete (3rd rev.) (Amendment 2)
4.	IS:3114:1994	Code of practice for laying of CI pipes (2nd rev.) (Amendment 2)
5.	IS:782:1978	Specification for caulking lead (3rd rev.)
6.	IS:783:1985	Code of practice for laying of concrete pipes (1st rev.)(amendment 1)
7.	IS:4127:1983	Code of practice for laying of glazed stoneware pipes (1st rev.)
8.	IS:780:1984	Specification for sluice valve for water works purposes (6th rev.) (50 to 300 mm size) (amendment 3)
9.	IS:1172:1993	Code of basic requirements for water supply, drainage & sanitation (4th rev.)
10.	IS:1200 (Part-16):1979	Code of practice for methods of measurements of building and civil engineering works: Part 16 laying of water and sewer lines including appurtenant items (3rd rev.)
11.	IS:1200(PART-19):1981	Code of practice for methods of measurements of building and civil engineering works: part 19 water supply, plumbing and drains (3rd rev.)
12.	IS:1742:1983	Code of practice for building drainage (2nd rev.)
13.	IS:13095:1991	Butterfly valves for general purposes
14.	IS:5312 (part 1) :1984	Swing heck type reflux valves (non-return valve): part 1 single door pattern (1st rev.)(amendment 1)
15.	IS:1726:1991	CI manhole covers & frames (3rd rev.)
16.	NBC-SP-7-1983 Part IV	National building code of India 1983, amendment No. 3
17.	IS:2065:1983	Code of practice for water supply in buildings

TECHNICAL SPECIFICATIONS

ELECTRICAL & LV WORKS

CHAPTER – A

TECHNICAL SPECIFICATIONS – ELECTRICAL & LV WORKS

1. HT PANEL:

1.1 DEFINITIONS:

The definitions shall be as per IEC-62271and other relevant IEC standards.

1.2 CODES & STANDARDS:

The contractor is required to follow all relevant IS and IEC codes as per the latest amendments, however in particular following codes may be applied in addition:

i. IEC-62271 - Standard for medium voltage switchgear and assemblies.
ii. IEC-60044 - Standard for instrument transformers.
iii. IEC-60099- Standard for surge arrester.
iv. IEC: 60255- Measuring relays and protection equipment
v. NEC- 2008 - National Electrical Code.
vi. NBC-2016 - National building code.
vii. IER-1956: Indian electricity rules.
viii. IEA-2007: Indian electricity act 2007
ix. Any other local byelaw or supply company norm as applicable.

1.3 SERVICE CONDITIONS:

1.3.1 System particulars (as applicable):

i. Nominal system voltage – 11 kV
ii. Rated system voltage – 12 kV
iii. Frequency- 50Hz ±3%
iv. No. of phases- 3
v. System neutral- Solidly earthed
vi. Short circuit rating – 25kA for 3sec

1.3.2 Tolerances and creepage distance:

Tolerances (on all the dimensions) and creepage distances shall be in accordance with provisions made in the relevant Indian/IEC/BIS standards and in these specifications. Otherwise, the same will be governed by good engineering practice in conformity with required quality of the product.

1.4 SPECIFICATIONS:

1.4.1 Panel Cubical:

i. Panel body shall be fabricated out of CRCA sheet steel throughout and shall have undergone 9 tank process or better. The thickness of sheet steel shall be as per the type test design of the manufacturer.
ii. The panel body shall be completely dust, corrosion, and vermin proof. The panel shall be powder coated with minimum coating thickness of 80 microns.
iii. Self-adhesive type, pu foam gaskets shall be provided wherever required.
iv. The panel shall be mechanically rugged to withstand the load of switchgears and busbars without any external bracing.
v. The panel shall have metal clad construction, fully compartmentalized with partition thickness of 2 mm or as per the type test design of manufacturer. The panel shall have separate compartments for switchgears and control gears.
vi. Panels shall be fully wired in factory complete in all respect. It is preferred to have

fabrication done through automatic advanced machines, CNC, robotic machines to ensure the best quality of fabrication.

vii. Panels shall be fully extendable from both sides and shall be easy to operate and maintain i.e. bus bar, metering, circuit breaker chamber, cables and cable box chamber should have proper access for maintenance. Separate compartments shall be provided for switchgears, Bus PT, metering & control gears, cable compartments.

viii. Width of each compartment shall not exceed 800mm. Total height of panel shall not exceed 2400mm.

ix. The compartments shall be designed such that breakers of same frame size up to 1250A are interchangeable in any of the compartments. Circuit breaker cubical shall be at the bottom and metering and control gear compartment shall be on the top.

x. A viewing window shall be provided in front of each breaker and PT compartment to see through the status of switchgear without opening the compartment door. These viewing windows shall also be tested for internal arc.

xi. All wiring in control compartment shall be routed through PVC ducts and shall be terminated on to stud type terminal with plastic cover. Internal wiring shall be done through FRLS copper stranded wires / cables.

xii. Control cable entry shall be from front and there should be a possibility of terminating to LV chamber from both right hand and left hand side.

xiii. Provision for lamps to be operated with door limit switch and a 6A socket operated through a toggle switch shall be made in control gear compartment.

xiv. Suitable guiding rails shall be provided in circuit breaker compartment for roll on floor type circuit breakers.

xv. The panel shall be well ventilated and shall have provision of cable entries from the bottom.

xvi. Gland plates shall be 3mm thick and holes shall be plugged in with fire retardant sealant.

xvii. The panel shall have IP-4X ingress protection and shall be resistant to high mechanical impact.

xviii. All doors shall be hinged type with a provision of padlocking.

xix. Provision of space heaters shall be made to absorb moisture in the panel compartments.

xx. The panel shall be suitable for grouting upon floor or MS channel. Bolt size and channel size shall be suitably selected in accordance with seismic one compliance.

xxi. The cable compartment shall be on the rear side with bolted box type back covers.

xxii. Cable boxes shall accommodate the required number of cables as per designed SLD.

xxiii. Sufficient headroom should be provided for cable termination. Creep age distances and clearances shall be as per BIS/IS/IEC criteria.

1.4.2 **Earthing:**

i. There shall be a continuous copper earth bus of size required size running at the bottom of the panel.

ii. Earth bus shall be robust and shall be capable of carrying full short circuit current for 1 second.

iii. Doors, covers and all non-current carrying metallic parts shall be earthed through flexible FRLS copper wires of required sizes.

iv. Earth continuity shall be maintained for each component in the panel board including its body and gland plates.

1.4.3 **Bus bars:**

i. Bus bar shall be provided in tubular / rectangular cross section made up of high electrolytic grade copper having good conductivity, suitable to carry rated current under steady state and shall be capable to withstand the thermal and electrodynamics stress

during transient conditions for 3 sec.

ii. Bus bar shall be designed for suitable current density not exceeding 1.0A/sqmm.

iii. Bus bar shall be designed for a temperature rise as per IEC.

iv. Busbar shall be supported upon insulated bushings and busbar supports shall be capable of withstanding thermal stress and electro dynamic forces during transient conditions.

v. Busbars shall be provided with heat shrinkable sleeves of equivalent voltage grade and shall run throughout the switchgear. PVC sleeves shall not be acceptable.

vi. Phase barriers of required material and thickness shall be provided in busbar as per type tested design.

vii. The bus bar edges/ ends shall be rounded off/ chamfered so that there will not be any sharp edges/projections.

viii. All fasteners (nuts/bolt) used for bus bar connections shall be of nonmagnetic stainless steel. Washers shall be provided for each nut bolt. If the fasteners used are not of stainless steel the tenderer shall state in their offer the material used and confirm that the same is non-magnetic and is superior to stainless steel.

ix. Clearances for busbars shall be as per the type test design of manufacturer.

1.4.4 **Circuit Breaker:**

i. The circuit breakers shall be vacuum circuit breakers and of horizontal draw out horizontal isolation type.

ii. All the three interrupters of individual phases shall be mounted on a common phase segregated epoxy body mounted on a truck for better insulation and avoidance of non-simultaneity of poles.

iii. Breakers shall be of 3 pole design for use in 11kV indoor switchgear. Circuit breakers shall be suitable for rapid reclosing cycle i.e. O-0.3 sec.-CO-30 sec.-CO.

iv. The circuit breaker shall be provided with motor operating spring charged closing. Spring charging motor shall be suitable for 240V, 50 Hz, single phase AC.

v. Provision shall be available for charging the springs manually as well, and to close circuit breakers mechanically.

vi. Provision for padlocks shall also be available.

vii. Tripping of the circuit breakers shall be through "shunt trip" coils rated for 110V DC auxiliary supply. It shall be possible to trip the breaker manually in case of necessity.

viii. All circuit breakers shall have mechanical ON/OFF indicator and spring charge indicator. These shall be visible from the front without opening the panel door. Also, there shall be provision for mechanical (manual) tripping and also for manual charging of the springs.

ix. Vacuum circuit breaker (VCB) shall be mounted on a withdrawable truck which shall roll out horizontally from service position to isolated position with ease and it shall also be possible to take out the breaker truck from cubicle smoothly on to the floor without use of any separate handling equipment.

x. It is preferable to provide a three-point guide for withdrawal and insertion of truck into the cubicle with ball bearing arrangement on the top of the truck. Truck shall have distinct ‘SERVICE’ and ‘TEST’ position.

xi. An isolated position by defeating the interlock shall also be inside the cubicle so that the front door of breaker compartment can be closed even in breaker isolated position.

xii. Special more than three point hinged locking arrangement shall be provided to prevent opening of door in the event of internal arc in breaker compartment.

xiii. Safety shutters which close automatically to prevent accidental contact with the live bus after withdrawal of the circuit breaker shall be provided.

xiv. Wherever the breaker is provided with earth switch, the same shall be mechanically interlocked with the circuit breaker. The earth switch shall be connected on line side of VCB.

xv. Where integral earth switches are not provided, suitable earthing trolleys shall be offered to facilitate earthing of out-going feeder circuits. Separate earthing truck shall be provided for bus earthing and cable earthing.

xvi. The earthing truck shall be so designed that it is impossible to earth a live. It shall be provided with capacitive voltage divider and complete with audio visual annunciation.

xvii. In addition to scrapping earth in auxiliary plug and socket proper arrangement should be made so that during engagement of the breaker in service condition earthing contacts is made first before isolating power contacts are engaged.

xviii. The auxiliary supply to these earthing trolleys shall be through 110V DC supply. An emergency mechanical push to trip button shall be provided for emergency manual tripping with front door closed. Auxiliary plug and socket shall be of minimum 24 pin plug type and shall have scrapping earth feature.

xix. Touch panel type, high resolution HMI screen shall be provided in front fascia with each panel so as to see the status of switchgears and meters in it.

xx. Typical parameters for 11kV circuit breaker shall be as follows respectively:

a. Rated voltage: 12kV
b. Basic insulation level (BIL): 75kV
c. Power frequency voltage withstand (1 min): 28kV
d. Rated symmetrical breaking capacity for 3 sec: 25kA
e. Rated steady state current rating: 800A / 630A

1.4.5 **Electrical features and safety interlocks:**

i. The panel shall be internal arc tested for 1 sec for rated fault level of incoming switchgear for all front, rear and lateral side of each compartment. Each compartment of panel shall be fully type tested as per criteria laid under IEC norms, from CPRI or ERDA.

ii. High voltage compartments shall be provided with pressure discharge flap for the exit of gas due to internal arc to insure operator safety.

iii. The switchgear panels shall be suitable for loss of service continuity LSC 2B as per IEC-62271-200 so that in case one compartment is under service, the other compartments shall not loose supply continuity.

iv. Safety shutters shall be metallic and shall be provided to cover up the fixed high voltage contacts on bus bar and cable sides when the truck is moved to Test / isolated position. The shutters shall move automatically, through a linkage with the movement of the truck and shall be of gravity fall type only. It shall be possible to padlock shutters individually.

v. Door interlocking features shall be provided in all front and rear doors/cabinets. Racking interlock shall be provided for all switchgear compartments.

vi. Switch gear cubicle shall have seal off bushing arrangement between the circuit breaker compartment and bus bar / C.T. cum cable compartment, i.e. the fixed isolating contacts shall be embedded in epoxy cast bushing so these act as seal off bushing to prevent transfer of arc from one compartment to the other in the event of internal arc within the cubicle & must be tested for internal arc in all three HV compartments as per IEC 62271-200.

vii. Circuit breaker can be inserted only in open position. Likewise, circuit breaker in closed position cannot be withdrawn. Attempt to draw out closed breaker shall not trip the breaker.

viii. The circuit breaker shall operate only in one of the three defined positions i.e. service, test and isolated. The breaker shall not close in any of the intermediate positions.

ix. The circuit breaker cannot be inserted into service position till auxiliary contacts are made. Similarly, interlock prevents auxiliary contacts from being disconnected, if circuit breaker is in service position.

x. It will not be possible to rack out the withdraw able part from service to test position when the switching device is switched ON. Similarly, it will not be possible to rack in the withdraw able part from test to service position, if the switching device is switched ON.

xi. Any attempt to rack out withdraw able part from service to test position will not result in switching off of the circuit breaker instead the service position will be locked till switching device is ‘ON’.

xii. It will not be possible to rack in or rack out withdrawable truck when the front high voltage door is open. However, a suitable defeat interlock mechanism is provided for emergency purpose.

xiii. It will not be possible to rack in the withdrawable truck from test to service position when the low voltage control plug is not in position and locked on the truck itself.

xiv. It will not be possible to close the door if the low voltage control plug is not engaged.

xv. Pull out type, rotary switch shall be provided for breaker to cut off the power manually during any emergency. This switch shall latch the breaker in off state in such a manner that untill the switch is rotated back to its normal position the breaker should not turn on under any circumstance.

xvi. Two position, selector type, auto manual switch shall be provided, with clear markings of Auto and manual positions engraved with good quality and shall be long lasting. Once the selector switch is put on to manual position all remote functions shall get defeated.

1.4.6 **Potential transformer (PT):**

i. Potential transformer shall cast resin type with copper windings and good quality ferromagnetic core.

ii. Losses shall be as per relevant standards.
iii. PTs shall have inbuilt fuses on primary side rated at 11kV shall be suitable to be mounted on the incoming line VCB
iv. PT shall have external fuses rated at 110V on secondary and tertiary sides and shall be provided with isolating plugs.
v. Bus PT shall be withdrawable type and shall housed in a separate compartment.
vi. Trolley shall be provided to safely rack out PT.
vii. PT windings shall be connected in star configuration with its neutral grounded with suitable size conductor to the grounding bus of panel through terminal links.
viii. Typical parameters for 11kV PT shall be as follows respectively:
   a. Rated primary voltage / phase: (11/1.732) kV
   b. Rated secondary voltage / phase: (110/1.732) V
   c. Class: Metering class - 0.5, Protection class - 3P
   d. Burden: 50VA

1.4.7 **Current transformer (CT):**

i. Current transformer shall cast epoxy / resin type with copper windings and good quality ferromagnetic core.
ii. Current transformers shall be single core type suitable for cable or bus mounting as required.
iii. CTs characteristics shall be suitably matched for differential a restricted earth fault protection so as to avoid nuisance operations.
iv. Vendors shall have to furnish CT calculations during the time of approval of product data.
v. Losses shall be as per relevant standards.
vi. Manufacturer shall provide suitable CTs with all its required characteristic curves.
vii. CTs shall be rated to withstand the fault level for 1 sec.
viii. CTs shall be provided with open able switch type shorting CT links.
ix. Grounding terminal of CT shall be grounded with suitable size conductor to the grounding bus of panel through terminal links.
x. Typical parameters for 11kV CT shall be as follows respectively:
   a. Rated voltage: 11kV
   b. Rated secondary current: 1A
   c. Class: Metering class - 0.5
   d. Class: Protection class - PS (for differential and restricted earth fault) Protection class - 5P10 (elsewhere)
   e. Burden: 10VA

1.4.8 **Surge arrester:**

i. Surge arrester shall be made up of metal oxide varistor, with air gaps suitable for mounting inside 11kV HT panel.
ii. Surge arrester shall be connected to each phase.
iii. Complete assembly of surge arrester shall be housed in a polymer housing.
iv. Surge arrester shall be capable to withstand both lightning and switching surges.
v. Grounding terminal of surge arrester shall be properly grounded with suitable size conductor to the grounding bus of panel.
vi. Typical parameters for 11kV surge arresters shall be as follows respectively:
   a. Rated voltage: 9kV
   b. Rated current: 10KA
   c. Peak current: 100kA

Note: Other parameters and characteristics shall be as per IEC-60099.

1.4.9 **Indication lamps:**

i. LED type Indication lamps shall be provided with max power rating of 2W.
ii. Lamps shall be capable to operate on 63.5V-110V AC / 110 bipolar DC as required.
iii. Lamp circuit shall be protected by a control fuse or MCB as required.
iv. Color of lamps shall be as per standard industrial practice or as required.

1.4.10 **Annunciation window:**

i. Annunciation window shall have compartmentalized windows of required numbers and

sizes and shall be suitable for mounting in panel front.

ii. Engraving shall be with a good quality material and shall be long lasting.

iii. Manually written stickers or test hand written with markers are not acceptable.

iv. Color of each window shall be red with letters engraved in black.

v. Size of the letters shall be such that the same is readable from at least 1.5 meters from the line of sight and shall be as required.

vi. Annunciation window shall be suitable for 230V, 50Hz, AC UPS supply.

vii. Required window of annunciation panel shall glow in case of receipt of control signal.

viii. Max power consumption shall not exceed 3W.

ix. Annunciation window shall have a provision of acknowledge, reset and power off in the front fascia.

x. Annunciation window shall have IP-40 protection.

1.4.11 **Hooter:**

i. Hooter shall be electronic type and shall be suitable for mounting in panel front.

ii. Hooter shall be able to deliver 80db sound level at every3 meters.

iii. Hooter sound shall be selectable for both hooting and siren type.

iv. Hooter shall be suitable for 230V, 50Hz, AC UPS supply.

v. Max power consumption shall not exceed 5W.

vi. Hooter shall be capable to operate up to 70 degree celsius.

vii. Hooter shall have red LED indication for power on.

viii. Hooter shall stop once the alarm is acknowledges from annunciation window.

ix. Hooter shall have a provision of reset and power off in the front fascia.

x. Hooter shall have IP-40 protection.

1.4.12 **Relay:**

i. Relays shall be numeric type, microprocessor based for feeder protection and shall have following required programmable protections:

   a. Instantaneous (overcurrent and earth fault.)
   b. Overcurrent
   c. Earth fault
   d. Overvoltage
   e. Under voltage
   f. Frequency
   g. CT / PT supervision
   h. Phase sequence
   i. Broken conductor protection based on negative sequence current to positive sequence current.

ii. Relays shall be numeric type, microprocessor based for transformer protection and shall have following required programmable protections:

   a. Differential
   b. Restricted earth fault
   c. High oil temperature
   d. High winding temperature
   e. Sudden pressure.

iii. Relays shall be hinged armature type, electromechanical, for following required protections:

   a. DC failure
   b. PT fuse failure
   c. Lockout

iv. Relays and circuit breakers shall be fully co-ordinated to achieve total discrimination up to main LT panel inside each distribution substation.

v. Separate numeric relay shall be provided for feeder and transformer protection.

vi. Relay shall confirm to IEC-61850 and shall be provided with Ethernet IP communication port

vii. Relay used for transformer protection shall have a feature to bypass the harmonic switching current at the time of transformer switching so as to prevent the breaker trip during switching of transformer. Circuit breaker shall be capable to handle the current at the same time.

viii. Numeric relays shall have self supervision function and shall be able to communicate and provide indication in case of internal fault in relay.

ix. Relays shall have inbuilt volatile and non volatile memories and shall be capable to record and store at least 100 events with date and time, with last five faults stored in non volatile memory.

x. 4 spare binary inputs and 4 spare binary outputs shall be provided in addition to those required.

xi. The operation of the relay shall be practically free from errors due to normal variations in frequency, waveforms & from ambient temperature effects range between - 20 degree to + 55-degree C.

xii. The relay shall have 3 independent time delayed O/C stages. The first stage should be programmable to have either a DT characteristics or IDMT characteristics described as follows and shall have a current

xiii. Setting range of 10% to 2500% and time setting range of 0 ms to 150 sec. The second and third setting shall have a current setting range of 50% to 4000%.

xiv. The relay should have 3 independent time delayed E/F stages. Should have a current setting range1% to 800% and time setting range of 0 ms to 100 sec. The lower setting is critical to take care of system which has low earth fault currents.

xv. The relay shall have reverse blocking or busbar blocking feature.

xvi. The relay shall have 8 Indication LEDs out of which minimum 4 should be freely programmable.

xvii. Relay shall be able to record at least 5 oscillographic disturbance records each of minimum 3 seconds.

xviii. Relay shall have independent setting groups.

xix. Relay shall have at least 4 shots of auto reclose function, switch on to Fault function, circuit breaker failure function, cold load pick up function. and inbuilt output relay latching function

xx. Relay shall have keypad buttons at front of the relay to configure the relay and shall be easily programmable and maintainable.

xxi. Aux Supply input voltage shall be 110VDC however relay shall be capable to operate at 24-250VDC / 240VAC.

xxii. Relay shall have its LCD display and any other control feature required in the relay shall be provided by the contractor at the time of product data approval at no extra time and cost.

1.4.13 **Multifunction Meter:**

i. Multifunction meter shall be electronic, digital type with inbuilt selector switches suitable to show parameters on 11kV.

ii. Multifunction meter shall be suitable for panel mounting.

iii. Meter shall have distinct indication upon front LCD screen for following (but not limited to) data and values:

a. Current (for all three phases)
b. Voltage (for lines and phases)
c. Power factor (Avg. and individual phases)
i. Active power kW (Avg. and individual phases)
d. Reactive power kVAr (Avg. and individual phases)
e. True power KVA
f. Frequency
g. Energy kWH (Avg., current, max in a day along with date and time, min in a day along with date and time)
h. Reactive kVArh (Avg, current)
i. Energy kVAh
j. Total harmonic distortion THD %
k. Current harmonics THDi (for harmonics up to 15th order)
l. Voltage harmonics THDv (for harmonics up to 15th order)

iv. Multifunction meter shall have accuracy class of 0.5 and shall have 2 DI/DO ports.

v. Multifunction meter shall be fully programmed from factory along with its CT ratio settings.

1.4.14 **Analog voltmeter:**

i. Voltmeter shall be analog type suitable with external selector switch.
ii. Voltmeter selector switches shall be four position type. Selector switch shall be suitable for semi flush mounting with only switch front plate and operating handle projecting out.
iii. Range of voltmeter shall be 0-12000V for 11kV
iv. Voltmeter shall be PT operated with accuracy class 0.5
v. Deflection needle shall be self-adjustable type.
vi. Front fascia shall have glass/polycarbonate cover.
vii. Range shall be properly engraved in the front fascia and shall be easily identifiable.

1.5 INSTALLATION:

i. HT panel shall be installed upon base channel ISMC -100 and shall be properly grouted on to the floor internally through bolts of proper size.
ii. Installation shall be in compliance with seismic zone-4 and sizes of bolts and complete grouting have to be structurally verified with respect to that.
iii. Panel shall be installed and aligned straight with tolerance of +/- 2mm.
iv. Shims below the panel shall not be accepted at all.
v. Panel shall be installed so that required clearances are met and cable termination is easy.
vi. Installation shall ease operation and maintenance in future.

1.6 TESTING:

i. The equipment offered in the tender should have been successfully type tested at CPRI/ERDA/NABL laboratories for following tests in line with the relevant standard and technical specification, within the last 5 (five) years from the date of submission of drawing.
ii. The bidder shall be required to submit complete set of the type test reports along with the offer.
iii. The undertaking to this effect should be furnished along with the offer without which the offer shall be liable for rejection.
iv. If above tests are carried out on higher capacity of offered equipment, then the offer is considered for placement of order. However, successful bidders have to carry out the said type tests on offered type equipment before commencement of supply at their own expense.
v. Type test and routine test shall be conducted in accordance with the provisions made in IS/IEC. However, following test in particular shall be conducted. Reports pertaining to type test shall be furnished:

a. Switchgear panel (with circuit breaker installed):
   - Impulse voltage withstand test
   - H.V. dry 1 min power frequency withstand test.
   - Short time and peak withstand current test.
   - Short circuit test with basic duties.
   - Single phase breaking capacity test.
   - Temperature rise test
   - IR test on bus bars.
   - Phase rotation test.

b. Circuit breaker:
   - Mechanical endurance test.
   - Contact resistance test.
   - Injection test.
   - IR test.
   - High voltage test.

c. Current transformer:
   - Short time current test
   - Impulse voltage withstand test
   - Temperature rise test
   - CT turn ratio test.
   - Overvoltage inter turn test (OVIT)
   - Knee voltage test.

d. Potential Transformer:
   - Impulse voltage withstand test.
   - Temperature rise test

e. Relay:
- Accuracy test.
- Internal fault test.

Note: Impulse voltage withstand test, short time and peak current withstand test and short circuit test, and internal arc test shall not be carried on the panel being supplied. Type test certificate for similar rating and design of equipment shall be submitted by the manufacturer for establishing quality.

1.7 INSPECTION AND COMMISSIONING:

i. After receiving approval on GA drawings, the concerning vendor shall invite the owner's representative at factory works once single unit of each type of panel is ready.

ii. Owner's representatives shall be provided open access at factory works to see and analyze any part of process.

iii. Testing at factory shall be witnessed fully by the owner's representative.

iv. Once the panel is cleared from factory testing and is received at site, after its complete installation and testing, commissioning shall be done with all pre functional and functional tests, as required by the owner's representatives.

2. HT CABLE, LAYING, TERMINATION & MANAGEMENT:

2.1 SCOPE:

The scope of work shall include:

i. Supplying, laying, testing and commissioning of 11kV & 33kV grade HT cables as per cable schedule.
ii. Handling, loading, unloading and storage of 11kV & 33kV grade HT cables.
iii. Civil works, piping works and ducting works required for cable laying as per tender document.
iv. Cable termination using heat shrinkable termination kit as per MES specifications.

2.2 DEFINITIONS:

The definitions shall be as per IS 7098-Part 2, IEC 60050-461 and IEC 60502-2.

2.3 CODES & STANDARDS:

The contractor is required to follow all relevant IS and IEC codes as per the latest amendments, however in particular following codes may be applied in addition.

i. IS 7098-Part 2- Specifications for XLPE insulated thermoplastic sheathed cables, for working voltage 3.3 kV and up to 33kV (including 33kV)
ii. IS-1255 - Code of practice for installation and maintenance of power cable up to 33KV rating
iii. IEC 60502-2- Standard for cables for a rated voltage from 6KV up to 30kV (Um=36kV)
iv. IEC-60050-461- Definitions for cables.
v. IEC-60811 - Common test methods for cable insulation.
vi. IS: 10418 Specification for drums for electric cables.
vii. IS: 8130: Specification for conductors for insulated electrical cables and flexible cords
viii. IS: 5831: Specification for PVC insulation and sheath of electrical cable.
ix. NEC- 2008 - National electrical code.
x. NBC-2016 - National building code.
xi. IER-1956: Indian electricity rules.
xii. IEA-2007: Indian electricity act 2007

Any other local bye-law or supply company norm as applicable.

2.4 SPECIFICATIONS:

2.4.1 HT Cables:

i. HT cables shall be earthed type for 11kV & 33kV.
ii. Cables shall be heavy duty type.
iii. HT cables shall be an extruded dielectric i.e. XLPE (cross linked polythene) insulated with maximum operating temperature of 90 degree Celsius.
iv. The insulation shall have a temperature withstand capacity of 250 degrees Celsius for 5 seconds during short circuit conditions.
v. Thickness of insulation shall be not less than 3.4 mm.
vi. The cable shall also be capable of withstanding the temperature rise due to short circuits in accordance with IEC-60986.
vii. The cable shall be sheathed with PVC (Poly vinyl chloride). Both inner and outer sheath of the cable shall be made up of PVC with outer sheath being provided with FRLS (Fire retardant low smoke) insulation.
viii. The conductors shall be made up of plain aluminium or aluminium alloy with metallic layer surrounding the cores, either individually or collectively.
ix. Screening of individual cores shall consist of a conductor screen and an insulation screen. The conductor screen shall be non-metallic and shall consist of an extruded semi-conducting compound, which may be applied on top of a semi conducting tape.
x. The extruded semiconducting compound shall be firmly bonded to the insulation.
xi. The insulation screen shall consist of a non-metallic, semi conducting layer in combination with a metallic layer. The nonmetallic layer shall be extruded directly upon the insulation of each core and consist of either a bonded or strippable semiconducting compound.
xii. A layer of semi conducting tape or compound may then be applied over individual cores

or the assembly. The metallic layer shall be applied over either the individual cores or the core assembly collectively.

xiii. The inner coverings shall be extruded with approximate thickness of covering to be 2mm.

xiv. The material used for covering shall be suitable for the operating temperature of the cable and also shall be compatible with the insulation material.

xv. Cables shall be armoured and type of armouring shall be wound type made up of galvanized steel, hot or cold rolled of commercial quality.

xvi. Armouring shall be done on the inner covering as described. The thickness of armouring shall not be less than 0.8mm.

xvii. Cable shall be provided with an oversheath (black in color) and made up of a thermoplastic or elastomeric compound. This oversheath shall be suitable for operating temperatures of cable as specified. Termite protection shall be provided in the oversheath.

xviii. The thickness of this oversheath shall be min (0.035D +1) mm, where D is the diameter of cable.

xix. Typical parameters for 11kV cables shall be as follows:

a. Rated Maximum Voltage: 11 KV (rms)
b. Rated Frequency: 50 Hz
c. Grounding: earthed cable (E)
d. Rated Power Frequency Withstand Voltage (1 min): 28 KV (rms)
e. Impulse withstand BIL (1.2/50/micro Sec) Line to earth: ±75 kVp
f. Rated short time withstand current for 1 sec: as per fault level
g. Conductor material / size: Aluminium / as per cable schedule.

xx. Typical parameters for 33kV cables shall be as follows:

h. Rated Maximum Voltage: 33 KV (rms)
i. Rated Frequency: 50 Hz
j. Grounding: earthed cable (E)
k. Rated Power Frequency Withstand Voltage (1 min): 70 KV (rms)
l. Impulse withstand BIL (1.2/50/micro Sec) Line to earth: ±170 kVp
m. Rated short time withstand current for 1 sec: as per fault level
n. Conductor material / size: Aluminium / as per cable schedule.

2.4.2 **HT cable termination:**

i. All joints and terminations, except for separable insulated connectors shall be of the heat-shrink, cold-shrink, or cold-applied polymeric type design, manufactured and tested to meet the requirements of the relevant standards, including AS/NZS 4805 Parts 1 and 2 or equivalent and shall be suitable for application to selected cables as specified.

ii. All separable insulated connectors and accessories forming part of the connector system shall be of the dead-break shielded / screened type with a screen break, manufactured and tested to meet the relevant standards, including AS 2629. The separable insulated connectors shall be suitable for connecting particular single core polymeric cables to provide 11kV & 33kV test points adjacent to substation switchgear.

iii. All joint and termination kits shall be supplied complete in unit lots suitably packaged for storage containing all necessary materials.

iv. All joints and termination kits shall be supplied with the required cleansing solvents, cloth and abrasives.

v. Vendor shall provide with their Safety Data Sheets (SDS) for nominated solvents.

vi. No unapproved solvents shall be provided without prior agreement of the Purchaser. If required, sealants shall be supplied to effect seals on joints and terminations and shall be able to accommodate the creep or relaxation that may occur during installation of the accessories or during the normal cyclic loading of the cables.

vii. The sealant shall have adhesion properties to maintain hermetic seals at all times between components and the various cable sheath materials and connectors.

viii. Suitable lubricants shall be provided with the kits for separable connectors (elbows, tee connectors and plugs) to facilitate separation of the connector from the bushing or plug socket.

ix. All joints and terminations shall be designed so that a phase cross can be made in the joint or termination without stressing the cable insulation or insulation components.

x. The quality of joint should be such that it does not add any resistance to the circuit. The

materials and techniques employed should give adequate mechanical and electrical protection to the joints under all service conditions. The joint should further be resistant to corrosion and other chemical effects.

2.4.3 **Civil works:**

General material specifications for civil works shall be followed.

2.5 INSTALLATION, TESTING & COMMISSIONING:

i. Cables shall be supplied in wooden or steel drums of heavy construction of suitable size and packed conforming to IS 10418 or applicable internationally accepted standards.
ii. Wooden drum shall be properly seasoned sound and free from defects. Wood preservative shall be applied to the entire drum. A layer of waterproof paper shall be applied to the surface of the drums and over the outer most cable layer.
iii. Each drum shall carry the manufacturer's name, the purchaser's name, address and contract number and type, size and length of the cable, net and gross weight stenciled on both sides of drum.
iv. A tag containing the same information shall be attached to the leading end of the cable.
v. An arrow and suitable accompanying wording shall be marked on one end of the reel indicating the direction in which it should be rolled.
vi. Packing shall be sturdy and adequate to protect the cables, from any injury due to mishandling or other conditions encountered during transportation, handling and storage.
vii. Both cable ends shall be sealed with hermetically sealed by means of water blocking compound followed by heat shrinkable caps totally coated inside with mastic so as to prevent to cable for moisture penetration during transit, storage and laying.
viii. The vendor shall consider supply of cable on returnable drums basis. Contractor shall take back all the cable drums from site after successful laying, testing and commissioning of cables. The bidder may quote the prices accordingly.
ix. Cable shall be laid as per the drawings, in different mediums as mentioned in drawings
x. The cable trench work involves earth excavation for cable trench, back filling and removal of excess earth from site. The work site shall be left as clean as possible.
xi. The bottom of the excavated trench should be leveled flat and from any object which would damage the cable.
xii. Any gradient encountered shall be gradual.
xiii. The excavated cable trench shall be drained of all water and the bed surface shall be smooth, uniform and fairly hard before paying out the cable. The cable shall be rolled in the trench on cable rollers, spaced out of uniform intervals.
xiv. The paying out process must be smooth and steady without subjecting the cable to abnormal tension.
xv. The cable on being paid out shall be smoothly and evenly transferred to the ground after providing the cushion.
xvi. The cables shall never be dropped. All snake bends shall be straightened.
xvii. Suitable size cable stocking pulling eye shall be used for pulling the cable.
xviii. While pulling the cable by winches or machines, the tension loading shall be by tension indicator and shall not exceed the permissible value for the cable.
xix. The cable laying shall be performed continuously at a speed not exceeding 600 to 1000 meters per hour.
xx. The cable end seals shall be checked after laying and if found damaged shall immediately be resealed.
xxi. Sufficient number of heat shrinkable cable end sealing caps shall be stocked at site stores for testing and jointing work.
xxii. The integrity of the outer sheath shall be checked after the cable is laid in position. The inspection of cable on receipt, handling of cables, paying out, flaking, cushioning with sand or sieved compacted soil, back-filling, reinstatement of road surface, providing and fixing joint markers, route indicators, precautions of joint holes, sump holes and all necessary precautions that are required shall be carefully planned and in general conform to IS 1255-1983 or its equivalent.
xxiii. Buried cable trenches for the cables as specified shall be made including supply and installation of warning tape, protective tiles/ bricklayer of minimum class designation 50 (50kg./sq. cm.) cable protection covers for entire route, construction of jointing bays, backfilling of trenches and restoration as per specification.
xxiv. The cable shall be completely surrounded by well-compacted cable sand to such a thickness and of such size that the cable is protected against damage.
xxv. The thickness of the cable sand should normally be a minimum of 10 cm in all directions from the cable surface. Based on the evaluation of soil thermal resistivity along the cable route and after approval from the employer the contractor shall design,

specify, supply, lay and monitor the installation of thermal backfill surrounding the cables.

xxvi. The option on the use of the material that immediately envelopes the cable viz., thermal backfill or sand or sieved native soil rests with the employer.

xxvii. The contractor shall seek prior approval on the use of the enveloped material from the Employer before execution of the works.

xxviii. Normally back filling shall consist of the material earlier excavated. However, bigger stores or pieces of rock should be removed.

xxix. A pre-warning, red color plastic/PVC tape, 250 mm wide 100 microns thick, shall be laid at approx. 0.4 m above the cable specified depth, throughout the cable route.

xxx. The tape shall carry the legend printed in black continuously as under:
CAUTION: 33000 / 11000V HV CABLES'

xxxi. After the cables have been laid in the trench and until the cables are covered with protective covering, no sharp metal tool shall be used in the trench or placed in such a position that may fall into the trench.

xxxii. Straight and curved rollers used shall have no sharp projecting parts liable to damage the cable. While pulling through pipes and ducts, the cable shall be protected to avoid damage due to sharp edges.

xxxiii. The cables shall never be bent, beyond the specified bending radius.

xxxiv. Roads other crossings will be through HDPE/RCC hume pipe for each cable and restoration as per specification.

xxxv. Cable markers shall be provided all along the route and at the bending. Also the location of underground cable shall be clearly indicated on the marker.

xxxvi. Permanent means of indicating the cable route shall be fabricated supplied and erected as per approved drawings.

xxxvii. Markers provided shall be as per the field requirement, if the route passes through open fields, markers should be conspicuously visible above ground surface.

xxxviii. The marker should incorporate the relevant information-the name of the owner, voltage, circuit and distance of cable from the marker.

xxxix. The vendor shall ensure supply and installation of all critical installation materials like trefoil clamps, neoprene cushions, support brackets etc. as required for complete route to avoid damages of the cable.

xl. Neoprene cushion shall be provided at road crossings to avoid damage of cable due to vibrations during movement of vehicles.

xli. The emphasis should be laid on quality and selection of proper cable accessories, proper jointing techniques and skill and workmanship of the working personnel

xlii. At cable terminating end sufficient length of spare cable shall be left in the ground and at cable tray also at switchgear end, for future needs.

xliii. The rise of the cable immediately from the ground shall be enclosed in PVC/PE pipe of suitable diameter to protect against direct exposure to the sun.

xliv. The cable shall be properly fastened using non-metallic clamps.

xlv. Protection from contact with the exposed metal work at the termination shall be provided by resin bonded glass fiber shroud.

xlvi. All routine and acceptance tests shall be conducted as per IEC 60502-2 / 61442. All type tests conducted during last five years from the date of approval of drawing. as per IEC 60502-2.

xlvii. In particular, following test shall be conducted at site:

a. Torque wrench test on bolted connections.
b. Insulation Resistance Test.
c. Hi-Pot test.
d. Phase test.

3. DISTIBUTION TRANSFORMERS:

3.1 SCOPE :

The scope of work shall include design, manufacturing, supply, and delivery to site including lifting, shifting, installation of power transformer & distribution transformer at its required location along with testing commissioning and quality assurance. The scope shall also include associated wirings including both ac and dc wirings as well as control cabling within transformers and from transformers to other panels / DBs.

3.2 CODES & STANDARDS:

The design engineering manufacturing shall be in accordance with established codes, sound engineering, practices, and specifications and shall conform to the statutory regulations applicable in the country. The contractor is required to follow all

relevant IS and IEC codes as per latest amendments, however in particular following codes may be applied in addition.

i. IEA - Indian Electricity Act.
ii. IER - Indian Electricity Rules.
iii. IS 11171 : Specifications for Dry Type Power Transformers
iv. IEC- 60726- Standard for Dry Type Transformers
v. NBC 2016 - National Building Code
vi. IS 2026 - Specifications for Power Transformer
vii. IS 5 - Colors for Ready Mix Pains and Enamels
viii. SP 30 - National Electrical Code
ix. IS 325 - Three Phase Induction motors
x. IS 2071 - Method of High Voltage Testing.
xi. IS 2099 - Specifications For Bushings For Alternating Voltages Above 1000 Volts
xii. IS 3639 - Fittings and Accessories for Power Transformer.
xiii. IS 10028 - Code Of Practice For Installation and Maintenance Of Transformer
xiv. IS-3202 - Code Of Practice For Climate Proofing Of Electrical Equipment
xv. C.B.I.P Publication - Manual on Transformer.
xvi. IS 3637 - Gas Operated Relays
xvii. IS 6600 - Guide for Loading of Oil Immersed Transformer.
xviii. IS 335 - Specification for Insulating oil.

In case of any deviation /conflict of this specification with the codes & standards, the following order of precedence shall govern:

i. Specification, particular specification if any, and drawings.
ii. Indian regulations/codes and standards.

3.3 SPECIFICATIONS:

3.3.1 General:

i. All transformers of similar rating shall have identical features & characteristics both mechanical and electrical.
ii. The design shall incorporate every reasonable precaution and provision for safety of all those concerned in the operation and maintenance of the equipment keeping in view the requirements of Indian Electricity Rules. The design and manufacture of the transformers shall ensure its capability to withstand rough handling during transportation and installation. The workmanship shall be of highest grade and manufactured in accordance with the modern practice.
iii. Lifting eyes or lugs shall be provided on all parts of the transformer requiring independent handling during assembling or dismantling. In addition, the transformer tank shall be provided with lifting lugs and properly secured to the side of the tank for lifting the transformer complete with accessories either by crane or by jacks. The tank shall also be provided with two suitable lugs for the purpose of grounding.
iv. The transformer shall have a maximum continuous rating at the secondary terminals, of the specified KVA output, at specified normal pressure, frequency, altitude and temperature rise at principal tap.
v. The centre of gravity of the assembled transformer shall be low and as near the vertical centre line as possible.
vi. Complete transformer assembly shall be corrosion/dust/vermin proof and shall be made up of sheet steel, pre painted and galvanized.
vii. The transformer shall be stable with or without oil if centre of gravity is eccentric relative to track either with or without oil, its location shall be shown on the outline drawings.

3.3.2 Core:

i. Transformer core shall be made up of high quality ferromagnetic material of CRGO (cold rolled grain oriented) silicon steel laminations of high permeability (class M-4 or better). The laminations of transformer core shall be lapped one

over the other in such a way that there shall be no air gap and hence magnetic flux leakage shall be very minimal.

ii. Maximum flux density in any part of the core and yoke at rated voltage and frequency shall be such that the flux density with + 12.5 percent combined voltage and frequency variation from rated voltage and frequency shall not exceed 1.9 Tesla.

iii. The design of core should ensure low core losses. It shall be coated with hot oil proof insulation and bolted together and to the frame firmly to prevent undue vibration. Its design should ensure suitability and reduce to a minimum the transformer excitation current & eddy current losses. The core shall be fully insulated from the winding.

iv. All core-clamping bolts shall be effectively insulated from the laminations in order to eliminate any short circuit paths, magnetic or electrical. The core clamping bolts shall be insulated with enamel or varnish or impregnated paper. The varnish should have been in successful use for at-least five years. The laminations shall be of inter board type. The bolt passing though the core shall be insulated for 2 KV.

v. The core shall be provided with lugs for lifting the complete core and coil assembly of the transformer.

vi. The core and coil shall be properly secured to the tank such that core does not shift its position in case the transformer is shifted or during short circuit conditions. The core shall be effectively earthed to the tank.

vii. The transformer tank shall be supported on a structural steel base equipped with forged steel or cast steel single flanged bi-directional rollers suitable for moving the transformer completely with all accessories. Suitable jacks for lifting the transformer for changing the plane of rotation of the bi-directional rollers shall be provided by supplier. The inside and outside of the tank shall be cleaned thoroughly by chemical de rusting agents and shall be coated with insulating paint or varnish.

viii. The transformer tank and cover shall be of robust welded construction and sufficiently strong to withstand shocks likely to be encountered during transportation and installation. It shall be made of mild steel plates of adequate thickness, properly welded and gasketted to ensure rigid construction. It shall be able to withstand partial vacuum against standard atmospheric pressure. All weldings shall be uniform and bars to be ground for smooth surface finish.

ix. All joints shall be fitted with suitable oil tight gaskets. Suitable guides shall be provided for tanking & untanking the transformer core & winding assembly.

x. All welded joints shall be as per IS specifications.

xi. The tank shall be equipped with gun metal valves of standard screw connections for external piping for drainage, filtering and sampling of the oil or as per manufacturer's standard.

3.3.3 **Windings:**

i. The transformer winding shall be of high conductivity annealed, double wound, fully insulated, copper conductor suitable for respective voltage grade. These shall be fully insulated for rated voltage with required insulation of high dielectric strength, slow aging characteristics and oil resistant properties. The assembly shall be held in position under aerial thrust likely to be set up under terminal short circuits conditions. It is preferable to provide tow bushings for neutral point earthing (one inside the terminal block and one outside.)

ii. The windings shall be designed to reduce to a minimum out of balance forces in the transformer. The tapping shall be reinforced with insulating tapping as required.

iii. The windings shall be helical in construction & wound to close tolerances.

iv. Adequate mechanical bracings of the windings shall be provided and installation shall be designed in such a manner so as to ensure a uniform voltage distribution throughout the length of the windings during surge and short circuit conditions.

v. The windings shall be clamped securely in place so that they will not be displaced or deformed during short circuits. It is essential that windings should be subjected to thorough shrinking and seasoning process so that no further shrinking occurs at site. Adjustable devices shall be provided for taking up any possible shrinking of windings in service.

vi. The end turns of the high voltage windings shall be reinforced to the extent of

5% of the windings from the line ends so as to withstand abnormal transient pressure, if required.

vii. High voltage phase windings shall be marked both on the terminal boards inside the tank and outside the tank with capital letters, U, V, W. Similarly, the low voltage windings of the same phase shall be marked by corresponding small letters, u, v, w. The neutral point terminal being indicated by letter 'n'.

viii. Adequate safety devices shall be incorporated to prevent damage to transformer windings or tank due to overheating or system electrical faults. It should withstand short time transients.

ix. The coils shall be thoroughly vacuum dried and impregnated with varnish or oil. Liberal oil ducts shall be provided to ensure fluent circulation of oil and proper spacing to prevent formation of hot spot.

3.3.4 **Cooling:**

i. The transformer shall be adequately designed and effectively cooled to ensure its operation under full load conditions continuously and for short time under overload conditions.

ii. Cooling shall be done through natural air.

iii. Detachable type radiators shall be provided on the tank to facilitate cooling. These shall be provided with isolating valves at both ends, drain and air release plugs. The valves shall be butterfly type (as per IS: 1228) and leak proof.

iv. The radiators shall be constructed out of 1.5mm thick pre-stressed steel of welded construction or of tubular pipe construction. Adequate Fins shall be provided so as to increase the rate of dissipation of heat.

v. Transformer tank shall be provided with adequated ventilated louvers to ensure ventilation in the core and windings.

vi. Louvers shall be so designed so that ingress of dust and water is minimal

3.3.5 **Electrical Parameters:**

i. Typical Parameters for distribution transformer shall be as below:
   a. Power Rating: 800Kva (2Nos)
   b. Turn Ratio:11/0.433 kV
   c. Percentage Impedance: 6.25%
   d. Duty: Contineous indoor
   e. Type: Dry
   f. Losses as per: Latest ECBC latest amendement and Level-5
   g. Insulation: Class-F
   h. Tap Changing Arrangement: On Load Tap Changer
   i. RTCC Required: Remote
   j. Termination box with disconnecting facility on HV side suitable for: 11 kV(E) 3C x 240 sqmm XLPE Cable
   k. Termination box with disconnecting facility on LV side suitable for: 1.1 kV 3.5C x 300 sqmm XLPE Cable
   l. Neutral CT: 1250/1A, CL-PS, 15VA
   m. Tap Settings: "+5% to -15% in the steps of 2.5"
   n. IP rating: IP32
   o. Fault on HV Side (for 2 sec): 25 kA
   p. Fault on LV Side (for 1 sec): 50kA
   q. Temperature Rise: As per IS-11171 section-3
   r. Vector Group: DYN-11
   s. Grounding (Body): Soildly Grounded
   t. Grounding (Neutral): Solidly Grounded
   u. Power Frequency withstand voltage (Primary): 28 kV
   v. Impulse withstand voltage (Primary): 75kV
   w. Power Frequency withstand voltage (Secondary): 3kV

ii. Typical Parameters for power transformer shall be as below :
   a. Power Rating- As per DBR
   b. Turn Ratio-33/11 kV

c. Percentage Impedance-As per IS
d. Duty-Contineous Outdoor
e. Type-Oil Cooled- Level 2
f. Losses as per- latest ECBC
g. Insulation - Class-A
h. Tap Changing Arrangement-On Load
i. RTCC Required-Yes
j. Termination box with disconnecting facility on HV side suitable for-33 kV(E) 3C x 300 sqmm XLPE Cable
k. Termination box with disconnecting facility on LV side suitable for-11 kV(E) 3C x 300 sqmm XLPE Cable
l. Neutral CT-As per capacity
m. Tap Settings- "+5% to -15% in the steps of 2.5"
n. IP rating-IP-55
o. Fault on HV Side (for 2 sec) 31.5 kA
p. Fault on LV Side (for 1 sec) 25kA
q. Temperature Rise-As per IS-2026
r. Vector Group-DYN-11
s. Grounding (Body)-Soildly Grounded
t. Grounding (Neutral)-Solidly Grounded
u. Power Frequency withstand voltage (Primary)-70kV
v. Impulse withstand voltage (Primary)-170kV
w. Power Frequency withstand voltage (Secondary)-28 kV
x. Impulse withstand voltage (Secondary)-75kV

Note: Power transformers technical parameters shall be identical to existing power transformers installed at respective substations (as mentioned in the DBR).

iii. The bushing insulators of the transformer shall be of sufficient creepage length and shall be unaffected by atmospheric conditions due to weather, dust or rapid change of temperature likely to be met at site. These should be fully glazed porcelain type. All bushings shall be marked by means of label with symbols corresponding to connection diagram indicated in the diagram plate.
iv. The inherent regulation at normal balanced load at unity and 0.85 lagging power factor at a temperature of 75 dec. C. shall be stated in the tender and contractor shall guarantee the performance figures.
v. The regulation of the transformers shall be as per IS: 11171.
vi. Phase barriers shall be provided on HV and LV side as per the type test design.
vii. Wiring shall be done with PVC Insulated, FRLS, copper conductor and min size of wire used shall be 2.5sqmm.
viii. Internal wiring of transformer shall be color coded as per standard practice.
ix. Wiring shall be neatly done and wires shall be housed in flexible MS conduits.
x. Ferruling shall be done properly.
xi. Control wirings from different components shall be brought into a separate terminal block inside marshalling box.
xii. Marshalling box shall be gasketed and sealed properly to avoid the ingress of dust and moisture.
xiii. Proper ferruling shall be done inside marshalling box for circuit identification.
xiv. Marshalling box shall be provided with thermostat operated space heater and lamp controlled with door limit switch, 6/16A socket controlled with a toggle switch.
xv. Following contacts shall be provided in marshalling box:
    WTI – Alarm
    WTI – Trip
    OLTC Fail - Alarm / Trip
    OLTC PRV – Trip
    4 Spare Contacts

3.3.6 **Accessories:**

i. <u>General:</u>

a. The relative positions of fittings shall, as far as possible, be in accordance with stipulations made in Indian Standards, latest issue. However, the tenderer shall submit along with his tender a copy of sketch showing relative positions of various fittings of transformer offered by him.
b. Each transformer shall be supplied with all following fittings and accessories etc. which are normally considered part of the transformer as a unit and necessary for its operation, regardless of whether all the items have been mentioned in the tender enquiry or not:
   - Termination box with disconnecting facility on HV side suitable for: 11 kV(E) 3C x 300 sqmm XLPE Cable
   - Termination box with disconnecting facility on LV side suitable for: 4000A, FP, 65kA compact sandwich busduct
   - Bi directional rollers
   - Earthing terminals.
   - Winding temperature indicator. (WTI)
   - Rating and diagram plate.
   - Marshalling box with watertight lockable cover lid and all associated accessories as per schedules and specifications.
   - Explosion vent with double diaphragm and sight glass
   - Radiator with top & bottom shut off valve
   - Silica gel breather with oil seal
   - First filling of oil including make up fill
   - Buchholz relay with shut off valve
   - Tap Changing Arrangement-Off Load - "+5% to -5% in the steps of 2.5"
   - Tap Changing Arrangement-On Load for power transformer - "+5% to -15% in the steps of 2.5"
   - Magenatic oil level gauge
   - Pressure relief device
   - Conservator with drain valve
   - Oil temperature indicator. (OTI)
   - Drain cum bottom filter valve

ii. <u>Tap Changing Arrangement- Off Load - "+5% to -15% in the steps of 2.5":</u>

a. ON circuit tap-changing switch shall be three phase, Remote operated, for simultaneous switching of similar taps on all the three phases by operating an external handle/ hand wheel.
b. Operating mechanism of tap changer shall be suitably labelled to show the direction of operation for raising secondary voltage & vice versa.
c. Tap position marking shall be provided.
d. Arrangement shall be made for securing and padlocking the tap-changing switch at any working position. It shall not be possible to set and padlock in any intermediate position.
e. A suitable pressure relieving arrangement should be provided to take care of sudden pressure rise in the compartment.
f. Tap changing range shall be site adjustable on both +ve and –ve side and may change as per the site condition.
g. An engraved indicating plate shall be provided for the switch with a movable pointer to clearly show the voltage for which the tappings on each phase are connected. A provision shall be made so that the switch can be locked at any one of the correct positions. The whole arrangement shall be absolutely rigid and adequately insulated throughout.

iii. <u>Controls:</u>

Manual Control:

a. The cranking device for manual operation of tap changing gear shall be removable and suitable for operation by a man standing on ground level. The mechanism shall be complete with the following:
b. Mechanical tap position indicator which shall be clearly visible from near the transformer.
c. Mechanical operation counter.

d. Mechanical stoppers to prevent over cranking of the mechanism beyond the extreme position.
e. The manual operating mechanism shall be labelled to show the direction of operations for raising the secondary voltage and vice-versa.
f. A caution plate indicating that switch shall be operated only when the transformer is de-energised shall be fitted near tap switch.

iv. Winding temperature indicator (WTI):

a. Winding Temperature Indicator (WTI) shall be digital type.
b. The WTI should be of better accuracy and repeatability for longer periods. These instruments should be electrically isolated from input power supplies and hence safe to use in a computerised data acquisition system or recorder.
c. The scheme should be capable to indicate the Winding temperature of transformers in remote control room. This should have an output of 4mA to 20mA DC proportional to the temperature ranges.
d. Two separate alarm and trip contacts shall be provided.
e. Actual temperature display should be of 3 digits, 7 segment LED. Temperature range should be 0°C - 150°C
f. Resolution of 1°C
g. Output should be of
   - 4mA - 20 mA analogue output 1
   - 4mA - 20 mA analogue output 1 corresponds to 0°C -150 °C
   - 4mA - 20 mA analogue output 2
   - 4mA - 20 mA analogue output 2 corresponds to 0°C - 150 °C
h. Multiple temperature setting range
   1°C - 150°C
i. Operating ambient temperature
   0°C - 50°C
j. Power supply
   230 V AC
k. Housing
   Molded ABS
l. Method of fixing
   By brackets screwed in from the side**.**

3.4 INSTALLATION:

i. Installation of transformer shall be carried out in accordance with best engineering practices.
ii. Transformer shall be provided with bi-direction rollers and lifting lugs in such a way that transformer can be rolled in both vertical and horizontal planes upon suitable size guiding rails.
iii. Transformers shall be plinth mounted, installed upon base channel of suitable size and shall be properly grouted on to the floor internally through bolts of proper size.
iv. Complete installation shall be in compliance with seismic zone and sizes of bolts and complete installation have to be structurally verified with respect to that.
v. Transformer shall be installed and self-aligned straight with tolerance of +/- 2mm.
vi. Transformer shall be installed so that required clearances are met and cable termination is easy.
vii. Installation shall ease operation and maintenance in future.

3.5 TESTING & COMMISSIONING:

i. Type test shall be done in accordance with set Indian standards but in particular following type test reports shall be furnished:

a) Impulse voltage withstand test
b) Short circuit test.
c) Measurement of acoustic noise level.
d) Transformer ratio test at various taps
e) Open circuit test
f) Test for Loss measurement at no load, 25%, 50%, 75%, 100% & 110% loading
g) Measurement of impedance voltage/short circuit impedance (principal tap)
h) Measurement of no load current
i) Voltage regulation test
j) Di-electric test
k) Temperature rise

ii. Routine test shall be done for each transformer in accordance with set Indian standards but in particular following Routine test shall be done
a) Transformer vector group test
b) Measurement of insulation resistance.
c) Leakage Test (tank).
d) Heat run test
e) Separate source voltage withstand test

iii. The Contractor shall draw up and carry out a comprehensive inspection and testing programme during manufacture and commissioning of the transformer. The programme shall be duly approved by the Consultant.

iv. Contractor shall ensure that type tested equipment is only offered and routine test shall be conducted as per relevant standards in presence of Client representative.

3.6 DRAWING AND INFORMATION:

The vendor shall furnish following drawings/documents in accordance with enclosed requirement.

i. General arrangement of transformer.
ii. General arrangement of MV cable box with connection diagram.
iii. General arrangement of LV bus-duct and connection arrangement.
iv. General arrangement of marshalling box and wiring diagram.
v. Rating and diagram plate indicating % impedance etc.
vi. Type test and guaranteed technical parameters.

3.7 QUALITY ASSURANCE PROGRAMME:

i. Quality Assurance Programmed shall follow the requirements of Owner/Consultant as applicable.
ii. Quality Assurance Programmed involvement will commence at enquiry and follow through to completion and acceptance thus ensuring total conformity to Purchaser's requirements.

3.8 DEVIATIONS:

i. Deviation from specification must be stated in writing at the quotation stage.
ii. In absence of such a statement, it will be assumed that the requirements of the specifications are met without exception.

3.9 OTHER ASPECTS OF POWER TRANSFORMER

v. <u>First filling of oil including make up fill:</u>
a. The insulating oil used in the transformer shall be mineral oil of high flash point, low sludge value, low pour point and low viscosity. It shall comply with

the requirement of IS: 335 latest issue.

b. The oil must be free from all undesirable impurities which may affect dielectric strength, flash point and cooling action. It must be tested for all the tests specified in IS:335.
c. The transformer oil shall have a good stability against oxidation so that viscosity remains substantially unchanged during the many years of expected service life and without any sludge formation.
d. The oil shall be tested for its dielectric strength as per IS: 6792 and should be not less than 40 KV for 60 sec. and 50 KV instantaneous.
e. The transformers shall be supplied topped with mineral insulating oil upto required value for putting in service.
f. The transformer shall be supplied with first filling of oil. 10% extra oil shall also be supplied in sealed tins for topping at the time of commissioning.

vi. Buchholz Relay With Shut Off Valve:

a. The Buchholz relay shall be double float design, gas and oil actuated with separate electrical contacts – one for alarm and other for tripping. It shall be complete with glass windows, independent potential and reset contacts.
b. A machined surface shall be provided on the top of Relay to facilitate the setting of Relay and to check the mounting angle in the pipe and cross level of the Relay.
c. The pipe work shall be so arranged that all gas arising from the Transformer shall pass into the gas and oil actuated relay.
d. The oil circuit through the Relay shall not form a delivery path in parallel with any circulating oil pipe.
e. The Buchholz relay should have gas collection pit cock with extension pipe with proper fixing arrangement.

vii. Oil temperature indicator. (OTI):

a. Oil Temperature Indicator (OTI) shall be digital type.
b. The OTI should be of better accuracy and repeatability for longer periods. These instruments should be electrically isolated from input power supplies and hence safe to use in a computerised data acquisition system or recorder.
c. The scheme should be capable to indicate the oil temperature of transformers in remote control room. This should have an output of 4mA to 20mA DC proportional to the temperature ranges.
d. Two separate alarm and trip contacts shall be provided.
e. Actual temperature display should be of 3 digit, 7 segment LED . Temperature range should be 0°C - 150°C.
f. Resolution of 1°C
g. Output should be of:
   - 4mA - 20 mA analogue output 1
   - 4mA - 20 mA analogue output 1 corresponds to 0°C -150 °C
   - 4mA - 20 mA analogue output 2
   - 4mA - 20 mA analogue output 2 corresponds to 0°C - 150 °C
h. Multiple temperature setting range
   1°C - 150°C
i. Operating ambient temperature
   0°C - 50°C
j. Power supply
   230 V AC
k. Housing
   Molded ABS
l. Method of fixing
   By brackets screwed in from the side.
m. Serial communication ports with several on-board communication protocols.
   Two active serial communication ports, through RS-232 & RS-485.

viii. Silica gel breather with oil seal:

Each conservator vessel shall be fitted with a glass container type breather in which silicagel is dehydrating agent and so designed that

a. The passage of air through the Silicagel.
b. The moisture absorption indicated by a change in colour of the tinted crystals can be easily observed from the distance.
c. All breathers shall be mounted at approximately 1400 mm above ground level and shall be connected to the air cell of the conservator through pipe for the purpose of breathing during contraction or expansion of the air cell.
d. A suitable metallic cover should be provided on the pipe on which breather is provided at a location just above the breather so that it can protect rain water from falling directly onto the breather.

ix. Conservator with drain valve:

a. The conservator should be air cell/ atmoseal type to prevent direct contact of Transformer oil with atmospheric air for retarding oxidation contamination of oil.
b. The Air cell shall be made from suitable material with outer coating resistant to transformer oil & inner coating resistant to ozone & weathering.
c. The conservator shall be provided with necessary valves to drive out the air in the space between conservator wall & air cell during filling of oil, drain valves for complete draining of oil and cut off valves etc.
d. The conservator complete with necessary valves shall be provided in such a position as not to obstruct the electrical connections to the transformer from H.V & L.V Side.
e. The conservator shall be of capacity to meet the requirement of expansion of the total cold oil volume in the Transformer & cooling equipment and it should be such that the oil level will always be visible through the plain oil level gauge.
f. The conservator shall be designed so that it can drain oil completely by means of the drain valve provided when mounted. One end of the conservator shall be bolted into position so that it can be removed for cleaning purpose.

x. Magnetic oil level gauge:

a. One Magnetic type oil gauge shall be provided.
b. The oil level at 30 Deg. C. shall be marked on the gauge along with 1/4th Level, max & Min. level.
c. A plain oil level gauge of prismatic type is also to be provided on the opposite side of the conservator, on which MOG is provided with marking as per ISS.

xi. Tap Changing Arrangement-Off Circuit – As per MES norms

h. Off circuit tap-changing switch shall be three phase, hand operated, for simultaneous switching of similar taps on all the three phases by operating an external handle/ hand wheel.
i. Operating mechanism of tap changer shall be suitably labelled to show the direction of operation for raising secondary voltage & vice versa.
j. Tap position marking shall be provided.
k. Arrangement shall be made for securing and padlocking the tap-changing switch at any working position. It shall not be possible to set and padlock in any intermediate position.
l. A suitable pressure relieving arrangement should be provided to take care of sudden pressure rise in the compartment.
m. Tap changing range shall be site adjustable on both +ve and –ve side and may change as per the site condition.
n. An engraved indicating plate shall be provided for the switch with a movable pointer to clearly show the voltage for which the tappings on each phase are connected. A provision shall be made so that the switch can be locked at any one of the correct positions. The whole arrangement shall be absolutely rigid and adequately insulated throughout.

xii. Tap Changing Arrangement-On Load - "+5% to -15% in the steps of 2.5"

a. The diverter switch contacts shall be housed in separate air break chamber.
b. OLTC shall have an Air / Vaccum tap selector and arching switch or arc suppressing tap selector, provided with reactor or resistor for reduction of make and break arcing voltages and short circuits.
c. OLTC shall have motor driven mechanism.
d. The tap selector and arcing switch or arc suppressing tap selector switch shall be located in one or more air/vacuum compartments.
e. A suitable pressure relieving arrangement should be provided to take care of sudden pressure rise in the compartment.
f. Tap changing range shall be site adjustable on both +ve and –ve side and may change as per the site condition.
g. An engraved indicating plate shall be provided for the switch with a movable pointer to clearly show the voltage for which the tappings on each phase are connected. A provision shall be made so that the switch can be locked at any one of the correct positions. The whole arrangement shall be absolutely rigid and adequately insulated throughout.

xiii. Controls

a. Manual Control :
- The cranking device for manual operation of tap changing gear shall be removable and suitable for operation by a man standing on ground level. The mechanism shall be complete with the following:
- Mechanical tap position indicator which shall be clearly visible from near the transformer.
- Mechanical operation counter.
- Mechanical stoppers to prevent over cranking of the mechanism beyond the extreme position.
- The manual operating mechanism shall be labelled to show the direction of operations for raising the secondary voltage and vice-versa.
- A caution plate indicating that switch shall be operated only when the transformer is de-energised shall be fitted near tap switch.

b. Electrical Control:

This includes the following:
- Electrical local control from transformer marshall box.
- The control scheme shall have the following features:
- An interlock to cut off electrical control automatically upon recourse being taken to manual control.
- Selection of point of control local or remote, it shall not be possible for any two electrical controls to be in operation at same time.
- Reinforcement of the initiating impulse for a tap change, ensuring a positive completion once initiated.
- Step by step operation, ensuring only one tap changes for each tap changing command.
- Interlock to cutoff the electrical control when it tends to perate the gear beyond either of the extreme tap positions.
- An interlock to block a counter command for reverse tap change during a tap change until the mechanism comes to rest and resets the circuits for a fresh operation.
- The equipment shall be so arranged so as to ensure that when a tap change has commenced it shall be completed independent of the control relays and switches.
- If a failure of auxiliary supply during a tap change or any other contingency would result in the movement not being completed adequate means shall be provided to safeguard the transformers and its auxiliary equipment.
- A supply monitoring relay with alarm contacts shall be provided for the tap changer.
- The auxiliary device for electrical controls of the OLTC shall be housed either in the OLTC driving mechanism box or in Transformers marshalling box.

- It shall be provided with a circuit breaker with magnetic and thermal O/L devices for controlling the auxiliary supply of the OLTC motor.
- Motor used for changing tap shall be IE-2 rated with its winding made up of copper and connected in delta. Appropriate capacity of OLTC motor shall be decided by the manufacturer and duly approved.
- The contactors and associated gear for the tap change driving motors shall be housed in a local kiosk mounted on the transformer.
- The motors shall be suitable for operation with 3- phase 400-433 volts, 50 cycle external power supply. Visual indication during the operation of motor shall also be incorporated.

xiv. RTCC

Tap position indicator shall be supplied loose for mounting on the RTCC.

RTCC shall have following components also:

a. Auto/Manual switch
b. Raise/Lower switch for manual operation
c. Lamp indicating ON LOAD TAP CHANGE in progress.

RTCC panel shall have automatic tap changing feature i.e. whenever voltage fluctuations occur the tap switch shall change automatically to set net output voltage as required.

RTCC circuit shall be provided with inbuilt AVR, with front LCD/LED screen showing tap position, raise/lower, AVR voltage etc. proper ferruling shall be done for circuit identification.

RTCC panel shall be provided with separate hooter and annunciation window for any fault in AVR and internal circuit.

RTCC panel shall be provided with thermostat operated fans and space heater and lamp controlled with door limit switch, 6/16A socket controlled with a toggle switch.

xv. Winding temperature indicator. (WTI)

m. Winding Temperature Indicator (WTI) shall be digital type.
n. The WTI should be of better accuracy and repeatability for longer periods. These instruments should be electrically isolated from input power supplies and hence safe to use in a computerised data acquisition system or recorder.
o. The scheme should be capable to indicate the Winding temperature of transformers in remote control room. This should have an output of 4mA to 20mA DC proportional to the temperature ranges.
p. Two separate alarm and trip contacts shall be provided.
q. Actual temperature display should be of 3 digits, 7 segment LED. Temperature range should be 0°C - 150°C
r. Resolution of 1°C
s. Output should be of
   - 4mA - 20 mA analogue output 1
   - 4mA - 20 mA analogue output 1 corresponds to 0°C -150 °C
   - 4mA - 20 mA analogue output 2
   - 4mA - 20 mA analogue output 2 corresponds to 0°C - 150 °C
t. Multiple temperature setting range
   1°C - 150°C

u. Operating ambient temperature
   0°C - 50°C

v. Power supply
   230 V AC

w. Housing
   Molded ABS

x. Method of fixing
By brackets screwed in from the side**.**

y. Serial communication ports with several on-board communication protocols.
z. Two active serial communication ports, through RS-232 & RS-485.

4. DIESEL GENERATOR:

4.1 SCOPE:

The scope of work shall include:

i. Supplying, installation testing and commissioning of DG set.
ii. Associated fuel and exhaust works.
iii. Associated power and control cabling.
iv. Acoustic treatment for all rooms where the DGs are being kept (Noise level shall be as per NBC-2016 guidelines)

4.2 DEFINATIONS:

The definitions shall be as per relevant IS / IEC standards.

4.3 CODES & STANDARDS:

The contractor is required to follow all relevant IS and IEC codes as per the latest amendments, however in particular following codes may be applied in addition.

i. IS 10002 / BS – 5514 – Engines
ii. BS-5000 - Alternator
iii. CPCB-II
iv. NEC- 2008 - National electrical code.
v. NBC-2016 - National building code.
vi. IER-1956: Indian electricity rules.
vii. IEA-2007: Indian electricity act 2007
viii. Any other local bye-law or supply company norm as applicable.

4.4 SPECIFICATIONS:

4.4.1 Engine:

The engine shall be stationary, compression ignition, totally enclosed, air cooled, 4 stroke direct injections, cold battery starting, turbo charged and low temperature with after cooled heat exchanger cooled, 1500 RPM complete with all accessories. The D.G. engine shall be suitable for black start. The DG engine shall be designed without any limitations on the number and frequency of starts in any given period. Electronic Instrument panel shall be provided for following indications:

i. RPM indication
ii. Lube oil pressure indication.
iii. Lube oil temperature indication.
iv. Starting switch
v. Water temperature indication.
vi. Electrical Hour meter
vii. Red emergency stop switch
viii. Day tank overfill limit indication & transfer pump shutdown
ix. Alarms/Trip (Audio and Visual)
x. The following Alarm/Trip indications shall be provided:
   a. Over speed.
   b. Low lube oil pressure
   c. High engine temperature
   d. Over crank/Failure to start

The bed plate for engine shall be fabricated from M.S. channel of size as required. The welding shall be radio graphed and the entire fabrication shall be stress relieved after welding. The bed plate shall have integral well ribbed diaphragms for supporting the main bearing housings. This plate shall have an integral lube oil pump and shall be mounted with the engine and exciter on a common steel sub-base.

The crank case shall be steel construction with heavy steel plates to form water compartments around the cylinder. To facilitate access to the big end and main bearings, crank shaft and governor adequate detachable doors shall be provided on both side of the crank case. Additional doors shall be provided to facilitate access for clearing of the water

jacket. These doors shall also be detachable.

The crank shaft shall be made of high tensile strength steel forging, and shall have a suitable flange to which the flywheel shall be bolted. The bearing journals and fillets shall be induction hardened; and fully balanced.

An A.C. motor driven intermittent operation lube-oil priming pump shall be provided. This shall also include necessary piping, fitting instruments etc. for lubrication system.

The main and big end bearings shall be detachable shells of high grade bearing material, and shall be pre-finished. The dimensions of the big end bearings shall be such that the connecting rods can be withdrawn through the cylinder liners.

The connecting rods shall be of high grade drop forged steel I - beam section, centre to centre length. The rods shall be rifle drilled for pressure lubrication of piston pin. The rod shall be tapered at piston pin end provided to reduce unit pressures. The piston pin of suitable diameter shall be full floating and made of tubular steel, and retained by a snap ring.

The cylinder liners shall be replaceable wet liners, cast in alloy iron, and provided with specially machined grooves in their bores to give an oil retaining surface. These liners shall be easily replaceable without re boring the block.

The piston shall be made of forged aluminum alloy, cam ground and machined on outer surface. The piston shall be fitted with an oil scraper ring, and compression rings of hardened cast iron alloy. The piston shall be oil cooled.

The camshaft shall be of induction hardened steel alloy with gear drive, and one of this shall be provided for each block of cylinders. The camshaft shall be built up in replaceable sections of heat treated precision machined steel with chromium plating. All the cams shall have hardened profiles. The fuel injection cams of the split removable type shall be doweled for angular location.

The exhaust manifold shall be multi-branch, of insulated design utilizing Ni-resist casting.

The flywheel, which shall conform to requirements of NEMA/ASA/BS codes, and shall be made of mild steel statically balanced after machining and shall have graduated markings around the periphery. This will facilitate checking of valves and fuel pump timing. Barring slots shall be provided around the flywheel rim for hand-barring.

The governor shall be Electronic type suitable for class A-1. This shall control the generator frequency, and shall be suitable for operation as per the selected battery voltage (24 V DC).
The governor shall be provided with a manually adjustable over speed trip mechanism to automatically shut-off the engine or the fuel supply if the set reaches 120% of rated speed. In addition to this, an engine mounted emergency push button/lever shall be provided. This shall trip the engine when depressed. This lever shall be suitably protected against accidental tripping. Exhaust Silencer shall be installed to reduce the noise level.

4.4.2 **Alternator:**

The alternator shall be brushless synchronous and suitable for 3 phase 400 Volts, 4 wire, 50 Hz, 0.8 pf., 1500 RPM. The alternator shall be suitable for coupling directly to the diesel engines described earlier. It shall be drip proof, screen protected as per IP 21. It shall include one set of suitable rated foot mounted anti - condensation heaters. The alternator shall be double bearing type and self-ventilating. The Alternators shall be provided with

fully interconnected damper windings to facilitate parallel running. The alternators shall be continuously rated and shall have class 'H' insulation designed and built to withstand tropical conditions. It shall generally conform to BS: 5000 (part - 99). The output of the alternators shall be suitable for sustaining a 10% overload for 1 hour in any 12 hour period without injury and also suitable for sustaining overload of 50% for duration of 45 seconds without injury. The terminal arrangement for alternator shall be suitable for terminating Aluminum sandwich type bus ducts of adequate size as per SLD to deliver the full load of the alternator. Nothing extra shall be payable for this arrangement. Droop CTs and CT for restricted earth fault protection shall be mounted in the alternator.

Exciter shall be Self-excited, self-regulated and providing alternator output regulation at plus or minus 2.5%. The alternator shall also have a solid state static type automatic voltage regulator (A.V.R.) suitable for single and parallel running with control limits of 1% from no load to full load under normal load changes when running single. It shall be of static type and shall be complete with cross current compensation. The regulator shall be provided with voltage adjusting potentiometer, and shall be complete with all alarm contacts, internal wiring, etc.
The excitation system shall be self-excited shall be equipped with all protection features. The Engine and Alternator shall be direct coupled and mounted on a common rigid fabricated steel base frame with suitable vibration isolation system.

4.4.3 **Fuel System:**

The entire fuel system for each engine-generator set shall conform to the requirements of IS and contains the following elements.

i. Pumps:

Each engine shall be provided with an engine driven pump. The pump shall supply fuel at a minimum rate sufficient to provide the amount of fuel required to meet the performance indicated within the parameter schedule. The fuel flow rate shall be based on meeting the load requirements and all necessary recirculation.

ii. Fuel Filter

Provide a minimum of one full-flow fuel filter for each engine. The filter shall be readily accessible and capable of being changed without disconnecting the piping or disturbing other components. The filter shall have inlet and outlet connections plainly marked.

iii. Relief/Bypass Valve:

Provide a relief/bypass valve to regulate pressure in the fuel supplyline, return excess fuel to a return line and prevent the build-up of excessive pressure in the fuel system.

iv. Day Tank:

Each engine shall be provided with a separate self-supporting day tank of 990 liter capacity fabricated out of 3mm thick MS plates (1M x 1M x 1M). A 450 mm dia manhole for easy access for cleaning & maintenance of these tanks shall be provided. Submit calculations for the capacity of each day tank and duration of fuel supply. Each day tank shall be provided with connections for fuel supply line, fuel return line, fuel overflow line, local fuel fill port, gauge, vent line, drain line, and float switch assembly for control. Level transducers, ultrasonic transducers, necessary control wiring terminations along with indications and alarm as per design scheme shall be provided. The fuel fill line shall be accessible without opening the enclosure. Each day tank shall have capacity to supply fuel to the engine for an uninterrupted 12-hour period at 100 percent rated load without being refilled. The calculation of the capacity of each day tank shall incorporate the requirement to stop the supply of fuel into the day tank at a "High" level mark of 90 percent of the ultimate volume of the tank.

Complete piping work shall be of M.S. class `C' (heavy duty) pipes conforming to IS: 1239 and fittings like tees, elbows, junctions, unions, bends, plugs, flanges and valves shall be

as per P.I.D. Civil work including cutting chases & filling the same shall be done with cement concrete 1:3:6 (1 cement: 3 coarse sand: 6 graded stone aggregate 20 mm

nominal size) or cement mortar 1:4 (1 cement: 4 coarse sand) as required. The pipes shall be painted with desired shade of enamel paint over a coat of primer.

Pumps used for the system shall be horizontally mounted single stage each capable of delivering required LPM at required head while running at required RPM, complete with tail pieces for proper connection to suction and delivery line. Flame proof motor suitable for 400 ± 10% V, 3 phase, 50 Hz AC supply and of suitable HP for pumps shall be provided. Flame proof on-off push button station (Push to lock & turn to release) of required rating suitable for the specified motors without no volt coil shall be provided including connection, interconnection in switch board. Common bed plate of required strength manufactured out of M.S. channels or of cast iron along with coupling and coupling guard shall be provided for direct coupling of pump and motor. Each day tank drain line shall be accessible and equipped with a shutoff valve. Self-supporting day tanks shall be arranged to allow drainage into a 305 mm tall bucket.

v. Local Fuel Fill:

Each local fuel fill port on the day tank shall be provided with a screw on cap.

vi. Fuel Level Controls:

Each tank shall have a float-switch assembly to perform the following functions:

a. Activate the "Low Fuel Level" alarm at 70 percent of the rated tank capacity.
b. Activate the "Overfill Fuel Level" alarm at 90 percent of the rated tank capacity.
c. Activate the automatic fuel supply shut-off valve located on the fill line of the day tank and shut down the fuel pump which supplies fuel to the day tank at 95 percent of the rated tank capacity. The flow of fuel shall be stopped before any fuel can be forced into the fuel overflow line.

Complete testing of fuel system to be performed at site including flush and fill operation, pump testing, leakage testing of all tanks, complete fuel philosophy to be tested and checked at site. All tools and accessories required for this testing shall be the scope of the DG Vendor.

In addition to that, the vendor shall also ensure first filling of all tanks with HSD after commissioning.

4.4.4 **Exhaust Piping Work**:

The exhaust silencer piping system shall be 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 recommendations of the manufacturer.

Exhaust pipe along with silencer inside the building shall be provided with mineral wool insulation of 75 mm thickness with chicken mesh wrapping and 24 SWG aluminum cladding to ensure that the temperature after insulation should not increase more than 10degC over site ambient at full load condition. All terminal connections and pipes joint shall be of welded construction. The terminals of sizes 2" and above shall be butt welded, and of sizes 1.5" and below shall be socket welded, complete with flanges, jointing and fasteners. This welding shall be done as per relevant ASME/ASA codes. The Contractor will have to indicate beforehand the welding procedure he proposes to use. After confirmation by the Engineer-in-Charge the procedure which is finalized shall be strictly adhered to. The Exhaust piping shall be done as per the requirement of engineer in charge upto the height as directed. Back pressure calculations shall be done by the OEM duly verified by the consultant. Expansion bellows wherever required as per calculations shall be provided by OEM.

4.5 INSTALLATION, TESTING & COMMISSIONING:

The following tests shall be performed at manufacture’s works prior to packing and dispatch to

site, in the presence of Project Manager/Consultant. A week's notice shall be given. Nothing extra shall be payable. If witness is waived off the contractor shall have to submit test certificate.

4.5.1 **On DG Set:**

a. Maximum power load capacity.
b. Maximum motor starting capacity
c. Endurance test.
d. Fuel consumption at full load, 50% load, 75% load and 25% load.
e. Transient loading test.
f. Overloading capacity @ 120% of full load capacity.
g. Voltage & Frequency drop test.

4.5.2 **On The Alternator**

a. Temperature rise test.
b. Stator voltage and current tests.
c. Stator phase sequence check.
d. Winding resistance test

4.5.3 **On The Exciter**

a. Temperature rise test.
b. Measurement of losses.
c. Insulation resistance test
d. Winding resistance test

4.5.4 **On The Automatic Voltage Regulator**

a. Sensitivity test.
b. Response time test.

All routine test as per IS/BS codes shall be conducted on alternator, exciter and AVR.
Computed results shall conform to the specified capacities and quoted ratings. Power consumptions shall be computed from measurements of incoming voltage and input current.
All the instruments required for testing shall be brought by contractor on returnable basis.

4.5.5 **Inspection and Testing at Site**

i. All pre-commissioning and commissioning test and checks shall be carried out at site. The test carried out shall be as per the relevant standards. The test shall include complete functional test of DG philosophy complete as a system including all its component and associated systems like fuel system, Exhaust system, cooling system, synchronization panel & synchronization philosophy etc.
ii. For examination and testing of materials and the works at site, the Contractor shall provide necessary testing and gauging equipment as required. All such testing and gauging equipment shall be tested for calibration at any approved laboratory as required by the Engineer-in-Charge.
iii. The Contractor shall give notice well in advance to the Engineer-in-Charge before commencement of any site testing. All materials like consumable stores, fuel oil grease, lubricating oil etc. required for the trails shall be arranged by the contractor.
iv. The Contractor shall make all necessary hook-ups to carry out tests at site and shall furnish necessary fuel.
v. The complete installation should be initially started and checked out for operational compliance by manufacturer's representative.

4.5.6 **Test Witness:**

Tests shall be performed in the presence of Engineer-in-Charge. The contractor shall give at least thirty (30) days advance notice of the date when the tests are proposed to be carried out.

4.5.7 **Performance Requirement:**

i. The D.G. set shall operate up to 110% of rated speed, without undue vibration and noise. The unit shall be capable of delivering rated output at 0.8 pf. at the generator terminals (after de rating of the engine due to site conditions).

ii. As soon as the set attains rated speed the transient voltage drop at the generator terminal shall not exceed 10% of rated value.

4.5.8 **Guaranteed Performance:**

The following items of performance shall be guaranteed by contractor in respect of D.G. sets, auxiliaries etc. when operating under site conditions specified elsewhere:

i. Net electrical output shall not be less than 80% of the rated output.
ii. Fuel oil consumption at 1/4, 1/2, 3/4 and full load shall not be greater than 3% of guaranteed specific fuel consumption as given in the Technical Data.
iii. Lubricating oil consumption shall not be greater than 5.0% of specified lube oil consumption as given in the Technical Data.
iv. 10% over load for one hour without overheating or showing signs of undue stress and within specified frequency variation.
v. Freedom from vibration and noise. Noise level should not exceed 105 dB. At distance of 1 m.
vi. Generator efficiency at 1/4, 1/2, 3/4 and full load to be as per technical data furnished.
vii. Governor response, over speed trip and speed gear capability.
viii. Voltage regulator response and voltage regulation shall be within + 1%.
ix. Excitation and full load under specified variation of speed and voltage. (The contractor shall indicate the standards according to which tolerances on the performance figures will be applicable.

5. BUS DUCT:

5.1 SCOPE:

The scope of work shall include:

i. Supplying, installation testing and commissioning of sandwich type bus duct
ii. Bus duct handling, loading unloading and storage.
iii. Associated structure works to install the bus duct.

5.2 DEFINITIONS:

The definitions shall be as per IEC-61439-1, 2 & 6.

5.3 CODES & STANDARDS:

The contractor is required to follow all relevant IS and IEC codes as per the latest amendments, following codes shall be followed in particular:

i. IEC: 61439-6 - Standard for busducts
ii. IEC-61439-1 & 2
iii. NEC- 2008 - National electrical code.
iv. NBC-2016 - National building code.
v. IER-1956: Indian electricity rules.
vi. IEA-2007: Indian electricity act 2007
vii. Any other local bye-law or supply company norm as applicable

5.4 SERVICE CONDITIONS:

5.4.1 System particulars:

i. Nominal system voltage - 415V
ii. Rated system voltage - 1.1kV
iii. Frequency- 50Hz ±3%
iv. No. of phases– 3P + neutral + Integrated earth
v. System neutral- Solidly earthed
vi. Short circuit rating – 25kA/36kA/50kA/65kA for 1sec on LV side.

5.4.2 Tolerances and creepage distance:

Tolerances (on all the dimensions) and creepage distances shall be in accordance with provisions made in the relevant Indian/IEC/BIS standards and in these specifications. Otherwise the same will be governed by good engineering practice in conformity with required quality of the product.

5.5 SPECIFICATIONS:

415 V, 3 Phase, 50 HZ, self cooled, sandwich construction, Aluminium bus duct as per the following specific requirements shall be provided.

5.5.1 Bus bars:

i. Aluminum bus duct, bus bar shall be fabricated from aluminium for the entire length.
ii. Rating of bus bar shall be as per data sheet, and it shall be 3Phase +100% Neutral+ 2 x 100% integral earth including bends.
iii. Busbar conductors shall be insulated with single/multilayer of insulation of class F.
iv. Electric connection shall be made at joints by single/multi bolt joint construction which ever suited. Joints shall be realized by a torque spanner (wrench) and shall be set as per the manufacturer design. To prevent the joints to be damaged during transport, they shall be protected by plastic caps, which shall be removed before installation.
v. Standard or designed locking system shall be put in place to prevent loosening of any screw and requiring any tightening schedule during maintenance. The design should have a provision to identify unraveling of the screw/nut by a degree and a marker to indicate, if the bolt has shifted from net position.
vi. Each bus bar shall be jointed to the adjacent section by single/multi bolt-joint clamps

without drilling the bus bar. Joint between two sections shall be such that a complete sub assembly is removable so that isolation of individual sections is possible without disturbing other sections. Inspection windows shall be provided over the joints to check tightness. Flexible connections shall be provided by braided or multi leafed conductors for termination.

vii. Bus trunking system shall be complete with all accessories like bends, Ts, vertical anchors, expansion joints, flexible connections etc. to suit site requirements. All accessories shall be deemed to be included in the straight length of the bus duct.

viii. The contractor will submit the Bus duct support calculation incorporating safety factor not less than or equal to 3 and dead weight of the bus duct along with hanging arrangement detail.

ix. The LT bus duct should be designed for maintenance free best service life in the industry and not less than 30 years for all types of installation & under prescribed environmental conditions.

5.5.2 **Enclosure:**

i. The enclosures of Bus ducts shall be totally enclosed. Ingress protection for the enclosures shall be min IP 55. The enclosure of Bus trunking System shall be fabricated from 1.6 mm thick CRCA sheet steel/ GI/ extruded Al and shall be powder coated to color shade RAL 7032 with a coating thickness of 80 microns after regress metal treatment process.

ii. Enclosure shall be rendered dust proof and vermin proof by adequate gasketing etc. to provide ingress protection of not less than IP 55. The gasket material shall be suitable for more than the class of insulation.

iii. The Bus bar trunking System shall be manufactured in convenient section to facilitate easy transportation and installation. The sections shall be connectable to form vertical or horizontal runs as required.

iv. Each section shall be provided with suitable support arrangement from walls / ceilings as required. Expansion joints may be provided as per manufacturer's design and recommendation.

5.5.3 **Flange end box:**

i. Flanged end box shall be provided to accommodate flange end for connecting the bus trunking with the flanges of panels and USS etc. through flexible connections.

ii. Phase matching of bus trunking with equipment shall be done prior to installation.

5.5.4 **Expansion joints:**

i. The bus bar system shall be equipped with standard expansion joints or with expansion bolts in each unit length to compensate thermal elongation of the bus bar.

ii. As far local conditions permit, the longest bus bar unit lengths shall be used to minimize electrical losses at the butt or bolted connections of the bus bars.

iii. The bus bar junction points shall be suitably marked for identification.

5.5.5 **Grounding:**

i. Bus trunking system shall be provided with two independent earthing GI conductors size of at least 50x6 (mm)/ as suitable throughout the length of the system.

ii. The earth flats shall be effectively connected to the enclosure by riveting bolting.

iii. End covers shall be provided as required. Neutral shall have same cross section as phases.

iv. All parts of the bus enclosure, supporting structures and equipment frames shall be bonded to the ground bus.

5.5.6 **Parameters**

i. Rated voltage- 1.1kV

ii. Rated current –800A to 4000A

iii. Frequency- 50Hz ±3%

iv. No. of phases– 3Phase + 100% neutral + integrated earth (2 nos.)

v. Short Circuit rating – 36kA for 1 sec / 50kA for 1 sec / 65kA for 1 sec.

vi. Peak impulse voltage - 12kV

vii. Insulation class - F

viii. Mechanical impact - IK-10

ix. Operating temperature (above ambient) – As per IEC

x. Total harmonic distortion - less than 15%

xi. Temperature derations: No deration up to 50 degree Celsius.

5.6 INSTALLATION, TESTING & COMMISSIONING:

i. Installation of the bus duct shall be carried out as per manufacturer's instructions and installation shall be verified by the manufacturer before energizing.

ii. For bus duct horizontal runs, horizontal expansion units shall be provided at suitable intervals at least every 40 m and at expansion joints of the building structure and the system shall be supported at least every 1.5 m

iii. Annular space around or Bus Ducts while crossing walls shall be filled up by fire retardant sealing material by contractor in accordance with the manufacturer's instructions.

iv. LT Bus Bar trunking system (Bus duct) offered shall comply to verification and type test requirements of IEC 61439-6.

v. Type testing shall be conducted from accredited Lab. Copies of the test certificates for same rating shall be submitted at the time of vendor approval. These shall not be more than 5 years old from the date of approval of drawing.

vi. Testing at manufacturers' works shall be conducted before dispatch as per routine verification requirements as per IEC 61439-6.

vii. Physical check including checking damage/crack in any components, tightness of bolts and connections etc shall be done at site.

viii. Insulation test after installation according to manufacturers test procedures shall also be done at site along with testing earth continuity.

6. LT CABLE, LAYING & TERMINATION:

6.1 SCOPE:

The scope of work shall include:

i. Supplying, laying, testing and commissioning of 1.1kV grade power cables and control cables suitable for 415V, 3Phase, 50Hz AC supply and also for 230V, 1Phase, 50Hz AC supply.
ii. Supplying, laying, testing and commissioning of 1.8kV grade, DC power cables suitable for 110V, bipolar DC supply.
iii. Handling, loading, unloading and storage of both AC and DC cables.
iv. Civil works, piping works and ducting works required for cable laying as per tender document.
v. Cable termination using double compression brass glands and lugs (Cu lugs for Cu cables and Al lugs for Al cables) as specified.

6.2 DEFINITIONS:

The definitions shall be as per IS 7098-Part 1, IEC 60050-461 and IEC 60502-2

i. Abbreviations used to define the following are stated in front of the entity
ii. Aluminum Conductor - A
iii. XLPE Insulation - 2X
iv. Steel round wire armor - W
v. Steel strip armor - F
vi. Steel Double round wire armor - WW
vii. Steel Double strip armor - FF
viii. Non-magnetic (A1.) round wire armor - Wa
ix. Non-magnetic (A1.) strip armor - Fa
x. PVC outer sheath – Y

6.3 CODES & STANDARDS:

The contractor is required to follow all relevant IS and IEC codes as per latest amendments, however in particular following codes may be applied in addition.

i. IS 7098-Part 1- Specifications for XLPE insulated thermoplastic sheathed cables, for working voltage up to 1.1kV (including 1.1kV)
ii. IS-1255 - Code of practice for installation and maintenance of power cable up to 33KV rating
iii. IEC 60502-1- Standard for cables for rated voltage from 1KV up to 6kV (Um=1.2kV)
iv. IEC-60050-461- Definitions for cables.
v. IEC-60811 - Common test methods for cable insulation.
vi. IS: 3961- Part 2: Recommended current ratings for cables.
vii. IS: 8130 Conductors for insulated cables.
viii. IS: 583 XLPE Insulation and outer sheath of electric cables.
ix. IS: 10418 Specification for drums for electric cables.
x. NEC- 2008 - National electrical code.
xi. NBC-2016 - National building code.
xii. IER-1956: Indian electricity rules.
xiii. IEA-2007: Indian electricity act 2007
xiv. Any other local bye-law or supply company norm as applicable.

6.4 SERVICE CONDITIONS:

6.4.1 System particulars:

i. System voltage - 415/230 V for AC cables and ±110V for DC cables
ii. Frequency- 50Hz ±3% for AC cables
iii. No. of phases- 3 for AC / 2 (poles) for DC
iv. System neutral- Solidly earthed
v. Short circuit rating - As per system fault level

6.4.2 Tolerances and creepage distance:

Tolerances (on all the dimensions) and creepage distances shall be in accordance with

provisions made in the relevant Indian/IEC/BIS standards and in these specifications. Otherwise the same will be governed by good engineering practice in conformity with required quality of the product.

6.5 SPECIFICATIONS:

6.5.1 **LT Cables (AC & DC):**

i. Cables shall be XLPE insulated PVC sheathed, Al or Copper conductor as specified.
ii. Cables shall be heavy duty type.
iii. Stranded Aluminum/Copper conductor shall be used.
iv. All Aluminum/Copper XLPE cables insulation shall be of high-grade Cross- linked Polyethylene for insulation for extrusion process. Cores laid up.
v. The inner sheath shall be bonded over with thermoplastic material for protection against mechanical and electrical damage.
vi. Armoring should be provided over the inner sheath to guard against mechanical damage.
vii. Armoring should be Galvanized steel wires or galvanized steel strips as specified.
viii. In single core cables used in A.C. wires/strips, round steel wires should be used; where diameter over the inner sheath does not exceed 13 mm, flat steel armor should be used.
ix. Insulation shall be of XLPE type as per latest IS general-purpose insulation for maximum rated conductor temp 90-degree C.
x. The Conductor shall be stranded Aluminum/Copper circular/sector shaped and compacted.
xi. In multi core cables the core shall be identified by red, yellow, blue and black coloring of insulation.
xii. Conductor shall be of electrolytic Aluminum/Copper conforming to IS: 8130 and are compact circular or compact shaped. I
xiii. In Inner sheath laid up cores shall be bonded over with thermo-plastic material for protection against mechanical and electrical damage.
xiv. Insulation, inner sheath and outer sheath shall be applied by extrusion and lapping up process only. The outer sheath shall have FRLS properties.
xv. Repaired cables or cables made up of re-used copper / aluminium shall not be used.
xvi. The cables shall be suitable for laying in racks, ducts, trenches, conduits and under ground buried installations with uncontrolled back fill and chances of flooding by water.
xvii. Progressive automatic in line sequential marking of the length of cables in meters at every one meter shall be provided on the outer sheath of all cables.
xviii. Both ends of the cables shall be properly sealed with PVC/Rubber caps so as to eliminate the ingress of water during transportation, storage and erection.
xix. Typical parameters for AC cables shall be as follows:
    a. Rated Maximum Voltage: 1.1 kV (rms)
    b. Rated Frequency: 50 Hz
    c. Rated Power Frequency Withstand Voltage (1 min): 3 kV (rms)
    d. Rated short time withstand current for 1 sec: as per fault level
    e. Conductor material: Aluminium / Cu. as per cable schedule.

xx. Typical parameters for DC cables shall be as follows:
    a. Rated Maximum Voltage: 1.5 kV
    b. Maximum permissible DC voltage: 1.8 kV
    c. Voltage withstands for 5 minutes: 6.5kV
    d. Rated short time withstand current for 1 sec: as per fault level
    e. Conductor material: Aluminium / Cu. as per cable schedule.

6.5.2 **LT cable termination:**

i. All cable glands shall be made out of brass and of good quality as approved.
ii. All cable glands shall be of double compressions type.
iii. Termination/ Joining of power and control cables shall be done by means of compression methods using solder less tinned copper or Aluminum terminal lugs.
iv. For control cables terminations, ring tongue or reducer pin type lugs shall be used to suit the purpose.
v. Proper crimping tools with crimping paste shall be used to maintain proper conductivity and avoid any air gap.

6.5.3 **Cable Tags:**

i. Cable tag shall be made out of stainless steel minimum 1.2 mm thick and 25 mm x 100 mm size with holes provided to tag the cable.
ii. Following information shall be engraved in the cable with good quality material and the lettering height shall be 4.5mm
    a. Source of the Cable from where it is supplied power.
    b. Destination where the cable is terminated.
    c. No of cores of cables.
    d. Cross sectional area of the cable

e. Complete notation as described under definition part of cable specification.

6.6 INSTALLATION, TESTING & COMMISSIONING:

i. Cables shall be stored in a dry covered place to prevent exposure to climate conditions and wear and tear of wooden drums and it should be preferably concrete surface.

ii. All drums should be stored in such a manner as to leave sufficient space between them for air circulation. It is desirable for drums to stand on battens directly placed under the flange.

iii. In no case should the drums be stored “on the flat” i.e. flange horizontal.

iv. Both ends of the cables shall be properly sealed with PVC/Rubber caps so as to prevent ingress of water, miniaturization of cores and armors during transportation, storage and erection.

v. On receipt of cable drums visual inspection of drums should be carried out for any damage to these cables.

vi. While unloading the cables certain precautions are to be taken to ensure the safety of cables. The cable end to be opened on one side and tested for its insulation and continuity.

vii. The cable drums should not be dropped or thrown from the trucks/railway wagons etc. during unloading operations as shock may cause serious damage to cable layers.

viii. A crane may be used for unloading cable drums. While lifting the cable drums with crane, it is recommended that the lagging should be left in place to prevent the flanges from crushing on the cables.

ix. If crane is not available a ramp should be prepared with approximate inclination of 1: 3 or 1: 4.

x. The cable drums should be rolled over the ramp by means of ropes and winches. Additionally, a sand bed at the foot of the ramp may be prepared to brake the rolling of the cable drum.

xi. Cable should not be dragged along the earth surface. Drums should be rolled in the direction of arrow only.

xii. For laying of cables special care is to be taken to prevent sharp bending, kinking, twisting.

xiii. Cable should be unwound from drum by proper mounting the cable drum on a cable wheel making sure the spindle is strong enough to carry the weight without bending and that it is lying horizontally in the bearings, so as to prevent the drum creeping to one side or the other, while itis rotating.

xiv. The maximum safe pulling force (when pulled by pulling eye) proper and safe method of pulling of cable should be used depending upon the site conditions to avoid any kind of damage to the cables. Following pulling forces to be noted.

a. Aluminum Conductor cables: 3.0 Kg/mm2

b. Copper conductor cables: 5 Kg/mm2

xv. Special care is to be taken while laying cable at bends. Following are the recommended bending radius for power and control cables.

Sr. No.	**Voltage rating (kV)**	**PVC / XLPE cables**	
		Multi core	**Single core**
1	Up to 1.1 kV	12D	15D
2	Above 1.1 kV to 33 kV	15D	15D

D = D is over all diameter of cable.

xvi. Armored cables are to be laid on cable trays/ underground as per relevant design drawing and specifications.

xvii. All flexible cables shall be laid inside exposed / canceled conduits (rigid / flexible)/ raceways or as per relevant design drawing and specifications.

xviii. After the cable trench has been properly excavated and straightened, it shall be covered with100 mm thick layer of sand, the cable shall then be lifted and placed over the sand cushion.

xix. It may be planned to lay down the cables in stacks under the trench and under such circumstances, cables shall be laid with the help of angular supports or cable trays suitable to take the load of the cable.

xx. In case the cable is laid with the help of angular supports inside the trench, such supports shall be provided at a regular interval so that the cable does not sag due to its weight.

xxi. After laying the cable the complete trench shall be filled with sand / earth up to 200 mm depth from the ground level.

xxii. A layer of silver sand along with a good quality caution tape with warning written in Hindi and regional language shall be laid throughout along the length of the trench at this level to indicate that electrical cables are running below and the area shall not be further excavated without suitable precautions and permissions.

xxiii. The complete trench may then be backfilled with earth up to ground level.

xxiv. Riggers shall ensure that while laying, the cable should not be subjected to any form of damage. Cables shall be laid by skilled and experienced workmen using adequate rollers to minimize stretching of the cable.

xxv. The cables shall not be laid in such a fashion that one cable crosses over the other. Proper spacing shall be left between two cables as mentioned in the GFC or as specified or directed by engineer-in-charge.

xxvi. Drain points shall be ensured inside these trenches so that in case of water logging, the water ejects out through these drain points as a result of natural gradient provided.

xxvii. Man-holes shall be provided at strategic locations so as to ease the pulling of cables and maintenance. The manhole shall be covered with suitable covers of mentioned material and dimensions as per GFC.

xxviii. When laid in cable trays above ground, power cables to be placed at the bottom most layer and control cables at the top most layer. In case of multi core power cables, cables shall be laid side by side with spacing not less than half the diameter of larger cable.

xxix. Multi-core cables shall be clamped by means of mild steel galvanized saddles. All cables below 1.1 KV single core cables if any should be clamped by means of non-magnetic saddles.

xxx. The saddles / clamps shall not be placed at the intervals more than 1500 mm for horizontal and1200 mm for vertical runs.

xxxi. Multi core control cables can be laid touching each other in cable racks and wherever required may be taken in two layers. These cables should be clamped by means of PVC straps for horizontal and vertical runs. Fabricated aluminum clamps may be used at regular intervals.

xxxii. All the cable shall be properly identified at regular intervals and care shall be exercised inlaying cables to avoid forming kinks.

xxxiii. The relative position of the cables, laid on the cable tray shall be preserved and the cables shall not cross each other.

xxxiv. At all changes in direction in horizontal and vertical planes, the cable shall be bent smooth with a radius as recommended by the manufacturers.

xxxv. All cables shall be laid with minimum half diameter gap and shall be clamped at every meter to the cable tray and shall be tagged for identification with cable tag and clamped properly.

xxxvi. Tags shall be provided at both ends and all changes in directions both sides of wall and floor crossings.

xxxvii. All cable shall be identified by embossing on the tag the information as laid down under this specification.

xxxviii. If there is a need to joint the cable due to finishing of cable in cable drum such joints shall be made through the approved straight through joints and jointing kits as directed by and approved by engineer-in-charge at site.

xxxix. Cables shall be fully tested (both type and routine test) as per the specification laid under Indian standards. In particular, following test shall be done at site.

a. Insulation resistance test.
b. Continuity test.

7. CABLE TRAYS AND RACEWAYS:

7.1 SCOPE:

The scope of work shall include:

i. Supplying, laying, testing and commissioning of cable trays, raceways and its allied accessories.
ii. Handling, loading, unloading and storage of cable trays and raceways
iii. Civil works associated with the said job.

7.2 DEFINATIONS:

The definitions shall be as per NEMA-VE-2

7.2.1 **Accessory:**

Components used to supplement the function of a straight section or fitting. Examples include, but are not limited to, dropout, cover, conduit adapter, hold-down device, and divider cable tray support.

7.2.2 **Span:**

The distance between the centerlines of supports.

7.2.3 **Cable tray system:**

A section or assembly of sections, and associated fittings, forming a mechanical system used to support cables and raceways.

7.2.4 **Channel cable tray:**

A fabricated structure consisting of a one-piece ventilated- or solid-bottom channel section.

7.2.5 **Connector:**

A component that joins any combination of cable tray straight sections and fittings.

7.3 CODES & STANDARDS:

The contractor is required to follow all relevant IS and IEC codes as per latest amendments, however in particular following codes may be applied in addition.

i. NEMA VE-2 -2013
ii. IS 1079, 2029, 2639 - Cable trays and their accessories
iii. NEC- 2008 - National electrical code.
iv. NBC-2016 - National building code.
v. IER-1956: Indian electricity rules.
vi. IEA-2007: Indian electricity act 2007
vii. Any other local bye-law or supply company norm as applicable.

7.4 SPECIFICATIONS:

7.4.1 **Perforated cable tray:**

i. Cable tray system shall comprise of hot dip galvanized G.I cable trays, with galvanizing thickness of 65 micron and standard length of 2.5 meters made out of 2 mm thick perforated sheet metal for cable trays which are 600mm wide and above and 1.6mm thick for cable trays whose width is below 600mm.
ii. The construction of the cable trays shall be as per the approved GA drawing from Vendor.
iii. The construction of cable tray shall follow NEMA standards.
iv. The cable trays shall be hot dip galvanized with perforations not more than 17.5% and factory fabricated out of G.I., angle iron, tee, bends, sections, flats and perforated sheet for different loads.
v. All accessories shall follow NEMA VE-2 standards

7.4.2 **Raceways:**

i. The proposed Raceway system shall be metallic adaptable raceway system.
ii. The raceways shall be made up of GI / Powder coated MS sheet.
iii. The raceways shall have suitable strength to pass under floor without breaking.
iv. The raceways must have smooth surfaces both inside and outside. The raceway shall

have Z- section, hole with thread for cover screw, coupler plate, cover, junction box, fly cover, inspection box flushed to the finished floor at suitable distances etc as required.

v. The screw for cover fixing shall be counter sunk type and shall be fully adjustable type.
vi. The cover shall have a thickness of 2mm.The min thickness of the raceways shall be 1.6mm and for 300mm wide raceway it shall be 2mm.

7.5 INSTALLATION, TESTING AND COMMISSIONING:

i. The Complete installation of cable trays shall be in accordance with NEMA VE-2 standards.
ii. Before installing cable in the cable tray, examine cable paths to ensure all areas are free of debris that may interfere with cable installation.
iii. Cable tray should never be used as a walkway.
iv. Most cable installations require the use of cable pulling tools on horizontal straight runs, cables generally ride on rollers mounted in or on cable trays.
v. These rollers should be properly spaced, depending on the size and weight of the cable, to prevent the cable from sagging and dragging in the cable tray during the pull.
vi. Cable manufacturer shall be contacted for information regarding proper roller spacing. Cables may be fastened to the cable tray by means of cable clamps or cable ties. Generally, cables shall be fastened every 450 mm (18 in) on vertical runs.
vii. Although not required by the NEC, single conductor cables can be fastened on horizontal runs to maintain spacing and ensure that the cable is confined within the cable fill area.
viii. When using cable clamps, the clamps should be sized correctly and tightened only enough to secure the cable without indenting the jacket.
ix. The same precaution should be observed with cable ties, and they should be applied with a pressure limiting device.
x. Extremely long vertical drops introduce a new set of issues requiring special consideration.
xi. The weight per meter (foot) of the cable multiplied by the number of meters (feet) in the vertical drop, in many cases, exceeds the load carrying capacity of the cable tray component. The one or two rungs supporting this weight are likely to be damaged, and the vertical load could exceed the allowable cable tension.
xii. The cable weight should be supported in such a manner as to prevent damage to the cable tray or cable during this type of installation.
xiii. As the cable is installed, intermediate supports should be installed on the vertical drop to break the cable load into segments supported at multiple places.
xiv. Once the cable is installed in an open cable tray system, care must be taken to protect the exposed cables from falling objects or debris that could cause damage to the cable.
xv. In areas where the cable tray is to be covered, covers should be installed as soon as possible. Temporary protection for the cables and cable tray can be constructed of available wood or metal materials until the risk of damage has passed.
xvi. Before installing a metallic adaptable raceway system clear marking shall be done at site for the route where the raceway is planned to be laid.
xvii. The location of junction boxed shall then be identified and marked upon the same routing.
xviii. The raceways shall be laid in straight sections exposed in service room area (as per drawings) and proper alignment shall be ensured for the same.
xix. The coupler plates shall be provided at regular interval as specified in approved construction methodology.
xx. All bolted connections shall be checked for their tightness and strength.
xxi. Inspection boxes shall then be laid and fixed at the strategic locations.
xxii. Raceways shall be protected by the means of thermacol or any water proof cover after their installation.
xxiii. Complete installation shall be in accordance with seismic requirements.

8. EARTHING:

MES & CPWD General Specifications for Electrical Works Part I Internal - 2013 (with latest updates) shall be followed completely (see Annex-2).

Digital Earthing shall be used for ELV and server applications.

Earthing system design shall be as per IS:3043 and AC substation grounding to be designed as per IEEE80:200

8-A LIGHTNING PROTECTION

Lightning Protection system shall be designed as per NBC-2016.

9. LT PANEL (TTA TYPE): L.V. SWITCH BOARDS

9.1 GENERAL

This Specification covers the general requirements for design, manufacture, testing and supply of LV Panels. The component requirements and details of the main distribution board(s) required are given on the schematic drawings and schedule of items / BOQ.

The Contractor shall install the LV Switch boards as shown in the drawings and in full compliance to this specification, the international standards specified in the following section & the local authority regulations. In case of difference between this specification, the specified international standards and the local authority regulations, the more stringent requirements in compliance with local authority regulations shall prevail.

9.2 MANUFACTURER & PANEL BUILDER / ASSEMBLER: PRE-QUALIFICATIONS

Main Switch board shall be assembled only by the original manufacturer or an authorised system integrator of the original manufacturer and approved by the consultant. The certificate copy issued by original manufacturer shall be attached with quotation document for review & acceptance. All major components like the Structure, switchgear components and bus bar supports shall be supplied by OEM manufacturer to the integrator/assembler. In case of licensed manufacture, enclosure parts may be manufactured as per drawings issued by original manufacturer with quality check. The QA documents, if required shall be furnished for review during inspection. Panel builder / Assembler / Licensee partner shall have a minimum experience of 10 years in the field of switchgear assembly. Reference list of past supplies shall be submitted for review.

9.3 APPLICABLE STANDARDS

Unless specified otherwise Main Switch board shall conform in design, material, construction and performance to the latest editions of the International recommendations (IEC standards) and its corresponding British / European standards (BSEN standards) and in particular to the following publications:

- Low Voltage Switchboard IEC 61439-1 & 2
- Degree of protection IEC 60529

- Mechanical impact IEC 62262
- Internal arc containment test in accordance with IEC 61641 (85kA for 0.4 Seconds)
- Seismic test zone- 4 as IEC 60083 as per IS 1893

In addition to the above listed standards, the local authority regulations shall also be adhered to.

9.4 SITE CONDITIONS

For general climatic conditions, refer and comply the specified project site conditions. The main distribution boards shall comply and perform satisfactorily at the below listed special design conditions as minimum:

Ambient temperature: -5 to 50 º C

Relative humidity: 95% (at 55 º C)

9.5 DESIGN CONSIDERATIONS

9.5.1 The main switch boards shall be of standard, natural air cooled, well tested and proven design which ensures maximum safety to personnel, maximum service reliability and economic operations. Design and construction shall be simple, well laid-out and shall provide good accessibility to components and parts.

9.5.2 Unless specified otherwise, the form of construction for the main distribution board shall comply with Form 4 requirements of IEC 61439.The external covers provided should have been subjected to minimum mechanical impact of IK10 as per IEC to ensure specified degree of protection.

9.5.3 Unless specified otherwise, the main switch board shall be fixed version, main incoming or Outgoing ACB shall be withdrawable type and the outgoing MCCB shall be fixed type.

9.5.4 Main switch boards shall be rated on the basis of voltage, current, frequency and the symmetrical breaking capacity of incorporated switching devices.

9.5.5 The electrical system for all main switch boards shall be 415V, 50 Hz 3phase and neutral, 4-wire solidly earthed. The main distribution board shall be suitable for operating voltage up to 690 V and Insulation voltage of 1000V.

9.5.6 Unless specified otherwise, the fault level withstand capacity of the LV Switch boards bus bar system shall be as mentioned in SLD/BOQ. The type test certificate shall be submitted for consultant engineer verification, to prove the fault level withstand capacity of the switch board. Even under extreme conditions of short circuit or mal-operation there shall be no danger to persons in the vicinity of the assembly.

9.5.7 All equipment and components of the main distribution boards shall be capable of continuous operation at their full current and voltage ratings and without detriment or malfunction at system continuous deviation of up to and including the following percentages of the normal values.

9.5.8 - Voltages ± 10%

9.5.9 - Frequency ± 5%

9.5.10 All components shall be capable of withstanding the dynamic, thermal and dielectric stresses resulting from prospective short circuit currents without damage or injury to personnel.

9.6 CONSTRUCTION REQUIREMENTS

9.6.1 General

9.6.1.1 The main switch boards shall be assembled by an authorized system integrator, who shall prequalify and comply with requirements specified under panel assembler pre-qualification of this specification.

9.6.1.2 Unless specified / approved otherwise, enclosure system, the switching devices and other components used for assembly of the main switch boards shall be from original manufacturer.

9.6.1.3 Enclosure system for all main switch boards rated up to 5000A to be of same model from one manufacturer. Unless specified otherwise, the main distribution board shall be of fixed version with cable access at rear for ACBs.

9.6.1.4 Type test certificates shall be available for the proposed type of enclosure and the busbar system.

9.6.1.5 The type test certificates shall clearly state type, model and main characteristics of the assembly, references of the standards applied for the tests, results obtained and the observations made during & after the tests.

9.6.1.6 Main switch board shall fully comply with requirements of Type Tested Assemblies as per IEC 61439.

9.6.1.7 Partially Type Tested Assemblies/non-type tested assemblies will be accepted if components are from the same manufacturer and partially type tested assemblies/non-type tested panels shall only be provided for the panels specified in the BOQ/schedule of items and remaining all panels shall be fully type tested.

9.6.1.8 Verified Design drawings, component catalogues and type test certificates shall be submitted for consultant approval prior to placement of order for the main distribution boards.

9.6.1.9 Vendor shall ensure components like ACB's, MCCB's selected shall be with discriminations. Published coordination chart or coordination study done using switchgear manufacturer's software shall be furnished along with drawing for approval.

9.6.2 General Arrangement & Assembly

9.6.2.1 L.V Panel shall comprise of free standing enclosure, bus bar system, switching devices such as ACB/MCCB, metering equipment's, all necessary current transformers and the like as required. Panel shall be assembled in a systematic manner such as Transformer Incomer section, Generator Incomer section, Bus coupler section, Incomer Metering / Indication section and Outgoing section.

9.6.2.2 Unless otherwise specified the panels shall be designed to accept bottom/top entry of cables and shall be of rear access type. The rear access shall only be provided for access for termination of cables, all other equipment's shall be accessible / operable from the front of panel. Where front access type is specified, the panel shall be designed completely for front access only.

9.6.2.3 Each panel section (cable compartment) shall be provided with thermostatically controlled panel heater.

9.6.2.4 Each section shall be arranged typically as described below and as per the details shown in the drawings:

a Incomer section (Incoming)

Incomer panel shall be a 3 compartment enclosure with Top & Bottom compartment dedicated for metering / controls and the Middle compartment shall be dedicated for the circuit breaker. It shall comprise of but not limited to the following:

Bottom Compartment - Incomer supply cables / bus duct

Middle Compartment - Main Incoming circuit breakers with rating and type as per the drawing.

Top Compartment - Any control component for Incoming circuit breaker, digital / energy meters, SPDs, phase indication lamps etc

b Bus coupler / Bus Tie section –

The Bus Tie / Bus Coupler Panel shall be a 3 compartment enclosure to match with the incomer panels. The Top & Bottom compartment can be used for accommodating the common controls of the incoming and the bus tie circuit breakers. The Middle compartment shall be dedicated for the circuit breaker. It shall comprise of but not limited to the following:

- Where ACB's are used as incoming or bus coupler, the front face of the ACB shall be accessible for operation from the front without opening the feeder door.
- Where MCCB's are used as incoming or bus coupler circuit breakers a rotary handle shall be provided at the front face of the MCCB which is operated from front door. All such handles shall be door interlocked to ensure safety for operating personnel.

c. Outgoing section(s)

The outgoing section(s) enclosure shall accommodate the outgoing circuit breakers which shall be arranged in a systematic and symmetrical manner. It shall comprise of but not limited to the following:

Each panel shall have various fixed compartments with individual doors for each compartment and each compartment shall accommodate the following:

- Circuit breakers with rating and type as specified in the drawings.
- Any other controls, which may be part of the outgoing circuit breakers along with Indication Lamps & metering as specified in SLD/BOQ
- All circuit breakers and other controls pertaining to a feeder shall be accommodated in its own compartment, which shall have its own feeder doors. Keys for all such external door shall be common.
- Molded case circuit breaker in each compartment shall be equipped with an operating handle extended to the front face of the door for operation. All such door handles shall be door interlocked to ensure safety for operating personnel.
- Air circuit breaker front face shall be accessible without opening the door.
- Circuit breakers and other control components shall be fully accessible after opening the panel door; however no live parts shall be exposed.
- All the bus bar connections / terminations to the outgoing MCCBs shall be taken from the front side of the circuit breaker, which shall be shrouded properly using metallic / poly carbonate sheets. All the mccb terminals shall be fully shrouded, in such a way that no live parts are exposed, when the front door is opened.
- Opening of the front door shall give access to the circuit breaker for rating adjustments etc.
- Maximum 2 nos. air circuit breakers shall be installed in one vertical, provided that sufficient space for cable termination is provided and de-rating of circuit breaker is carried out as per manufacturer recommendations.
- Maximum 2 nos. Molded case circuit breakers, rated at 800Amps shall be installed in one vertical, provided that sufficient space for cable termination is provided.
- Maximum 9 nos. of Molded case circuit breakers (rated less than 250Amps) shall be installed in one vertical, provided that sufficient cable termination is provided.

- All Partitioning and shrouding shall comply the requirements of Form-4B, construction as per IEC standards.

9.7 Enclosure manufacturing

9.7.1 The enclosure system shall be Modular in nature.

9.7.2 The enclosure shall be powder coated with RAL 9003 paint shade as specified. The painting process shall include removal of moisture on the sheet steel surface using and applying thermosetting polyester powder using automatic guns or Electrophoretic dip coating or a conveyorized cleaning process.

9.7.3 A continuous integrated coating of at least 70-80 microns shall be provided.

9.7.4 The pre-treated and powder coated sheet steel components shall be at least tested randomly at regular intervals for coating thickness measurement.

9.7.5 Enclosure construction

9.7.6 The assembler shall assemble the prefabricated elements of the enclosure system, busbar system, switching devices and other equipment to complete the main switch board.

9.7.7 Main switch board enclosure shall be fabricated of minimum 2mm for load bearing members and 1.5/1.6mm non-load bearing members. The enclosure shall be of simple and robust construction designed for a variety of dimensions obtainable by means of standardized basic elements. Main distribution board shall consist of several enclosures of equal height and depth mounted side by side to form a composite board of uniform assembly with IP 43/54 protection as per site requirement.

9.7.8 Enclosure structure composition shall be based on a supporting frame consisting of cross members, vertical members and panels fastened one another by means of bolts. Structure should be minimum 5 fold to provide high structural strength.The basic structure shall be completed by the addition of a compartment for the connections which may be located at rear or at side depending on the access. A single-piece base shall allow anchoring of the unit to the floor. The complete assembly shall be rigid self-supporting structure which is non deformable and unaffected by vibration/shocks.The complete assembly should be of bolted design without welding in any component. The structure shall be completed by a metal partition made of one or more pieces between two sections depending on the depth of the compartment. The lower part of structure shall be closed by means of bolted plates that can be removed whenever the assembly of cable glands is required. The switchgear components contained in sections shall be installed on mounting plates.

9.7.9 Each door panel shall be equipped with door interlock with mccb operating handle. All doors, bolted cover, partitions, mounting plates and metallic shrouds shall be effectively connected to earth. Enclosure structure shall have provision for conversion of bolted external doors to hinged doors as per site conditions Flexible earth wires shall be used for removable covers and hinged doors. Each vertical shall be provided with common lockable door to prevent unauthorized operation.

9.7.10 The structure and the partitions shall be protected by a durable scratch resistant textured paint finish, to an approved paint shade.

9.7.11 Unless specified otherwise, the main distribution board shall be with ingress protection rating as per IEC standards.

9.7.12 Unless specified otherwise, Main switch boards shall be designed for front access for the purpose of operation and access to all components and shall suit front or rear access for cable

connections and top or bottom for cable entries. Wherever required, enclosure shall be suitable for bus duct entry at the top. The access and entries shall be provided as per site requirements.

9.7.13 Adequate care shall be taken while designing the main switch board connection spaces for the external cables. Sufficient cable supports shall be provided for routing the cables inside the enclosure.

9.7.14 Enclosure system shall effectively dispose the heat produced by the main circuits and shall integrate a high performance natural ventilation system which shall be aimed at regulating the internal temperature based on the actual capacities of the components.

9.7.15 Enclosure shall be readily suitable for future extension on either side without any modifications (after installation at site).

9.7.16 Form-4B construction assembly shall provide protection against contact with internal live parts and components. Bus bar, functional units and cable termination shall be segregated from each other as given below:

9.7.17 - Bus bar shall be separated from functional units;

9.7.18 - Functional units/switching devices shall be separated from each other;

9.7.19 - Cable termination and functional units/switching devices shall be separated from each other;

9.7.20 - Incoming and outgoing terminals shall be separated from each other.

9.7.21 Bus bars shall be accommodated in a separate chamber/alley with metallic/poly carbonate shrouds and partitions to avoid accidental external contacts.

9.7.22 Incoming switching device shall be located in separate section and outgoing switching devices in other sections, wherever applicable. Each switching device shall be segregated from each other and located in individual compartment with hinged door.

9.7.23 External cable termination to the switching device terminals shall be outside the functional unit / switching device compartment. Segregation shall be made between the switching device terminal and the switching device within its compartment by means of rigid barriers and partitions.

9.7.24 All segregation shall be achieved by means of rigid metallic sheet partitions. Segregation and partition shall ensure protection against contact with live parts and limitation of the faults within each of the functional unit compartment.

9.7.25 A cable alley shall be provided either at rear or at the side of each section as per site conditions and requirements to facilitate termination of cables. Cables shall be glanded on the bottom/top plate of common cable alley/chamber. Supports shall be provided to fasten the power and control cables inside cable alley/chamber.

9.8 Bus bars

9.8.1 The bus bar system shall be designed as per the pre-defined guidelines provided by the original manufacturer. The bus bar system shall be type tested by the manufacturer at reputed laboratory for short circuit withstand capacity. The neutral and earth bus bars shall also be type tested for the short circuit withstand capacity. The fault level rating of the bus bar system shall be as per the drawings however the minimum short circuit withstand capacity shall be 50KA RMS for 1second.

9.8.2 Neutral bus bar shall be able to withstand a thermal stress of at least 50%, corresponding to the main phase bus bar rated short circuit withstand capacity.

9.8.3 The bus bars shall be of electrolytic grade (E91E or better) aluminum or copper of rectangular shape. The phase bus bars and neutral bus bars shall be arranged systematically in a bus bar

chamber/ alley. The bus bars shall be colour sleeved throughout the length for phase identification. The bus bars shall be shrouded completely using metallic partitions and/or polycarbonate shrouds as applicable. The bus bar assembly shall be suitably shrouded so that no live parts are accessible.

9.8.4 Use of Bakelite sheets for shrouding will not be permitted.

9.8.5 The busbar system shall be supported adequately at regular intervals as per manufacturer guidelines based on the type test results on a specially designed busbar supports. The supports shall be independently fixed to structure to strengthen the busbar arrangement. Wherever required additional intermediate supports shall be provided between the busbar. All vertical droppers shall also be adequately supported as per the manufacturer guidelines and the test results. The distribution busbar shall be connected to the main busbar by suitable sized and graded bolt & nut and contact washers. Connections to the switching devices to the main or distribution busbar shall be carried out using rigid bars of adequate and standard sizes.

9.8.6 Distance between the busbar supports for busbar system and the distance between different phases of busbar system shall be as per original manufacturer guidelines based on the type test results.

9.8.7 The main busbar shall be accommodated in a separate busbar chamber running horizontally at top or bottom of the panel.

9.8.8 The dimensioning of the busbar system shall be as per the rated current of the main switching device, the short circuit current, the maximum rated permissible temperature and the ambient temperature around the busbar. The selection of busbar shall be supported by calculations and recommendations from the original manufacturer.

9.8.9 The neutral busbar shall run along with the phase busbar and neutral termination for outgoing switching devices shall be provided with bolted link for isolation purpose.

9.8.10 Earth busbar shall be running throughout the panel fitted directly on to the structure for connection of the protective conductors to provide equipotential bonding of exposed conductive parts. Earth busbar shall be located at the bottom of the panel and in the cable chamber/ alley to facilitate easy connection of protective conductor.

9.8.11 The busbar joints shall be plated or provided with bimetallic washers for dissimilar material. The hardware used at joints shall be as per original manufacturer’s recommendation.

9.9 Testing

9.9.1 Type test

9.9.1.1 The main switch board and the components as applicable shall be type tested in accordance with the IEC standards to verify the specified fault level withstand capacity from a reputed and approved type testing laboratory and certified by an competent authority.

9.9.1.2 The following type tests as specified in IEC 61439-1standards to comply with requirements of TTA equipment shall be carried out at recognized test laboratories and certificates from approved test witnessing authority shall be provided for each type test:

1. Verification of temperature-rise limits (IEC Cl. 10.10);
2. Verification of the dielectric properties (IEC Cl. 10.9);
3. Verification of short-circuit withstand strength (IEC Cl. 10.11);
4. Verification of the effectiveness of the protective circuit (IEC Cl.10.5)
5. Verification of clearances and creep age distances (IEC C. 10.4)
6. Verification of mechanical operation (IEC Cl.10.13)

7. Verification of the degree of protection (IEC Clause 10.3)
8. Verification of mechanical impact (IEC Clause 10.2)

9.9.1.3 The panel should be tested for internal arc as per IEC 61641 for 85kA for 0.4 sec which guarantee safety to operating personnel in terms of arc containment and readiness of panel for normal operation after the clearance of fault.

9.9.1.4 Type test certificates shall be submitted to the consultant engineer for verification.

9.9.1.5 Also the panel should be seismic Zone 4 as per IEC 60068.

9.9.1.6 Routine test

The system integrator / panel assembler shall perform the routine test and provide the test certificates as defined in IEC standards. The routine test shall include but not limited to the following:

1. Inspection of the assembly including inspection of wiring and electrical operational test
2. Insulation resistance test (Megger)
3. HV tests
4. Checking of protective measures and of the electrical continuity of the protective circuits
5. Functional test as per the approved test procedure.

Routine test certificates and test readings shall be submitted to the consultant engineer for verification.

9.10 DRAWINGS

The Contractor shall prepare and furnish to the Consultant/Client detailed drawings of the boards and its parts with all the required information before supply of panels at site. The manufacture shall be taken up only after receipt of the approved drawings from the Electrical Inspector. The Contractor shall take action in this matter in such a manner that the process of submission of drawings and details and their approval by Consultant / Client are completed in time to adhere to the stipulated delivery period. The drawings and details to be furnished for Consultant's approval shall include the following:

- Front view, end views, plan and sectional views of the Board to clearly show all details relating to arrangement of various components, interconnections, clearances, etc.
- Schematic wiring diagrams of the main and auxiliary circuits.
- Bills of materials giving details of designation, make, type, rating, etc of the various component parts mounted on the board.
- Details which are not clear in the drawings shall be subject to necessary modification during inspection.

9.11 LOCATION OF INSTALLATION

The contractor shall inspect and study the proposed location of each board and ensure that the board is manufactured giving due consideration to site conditions, clearances required, transport route, etc. Clearances as per the relevant standards and as approved by the Inspectorate shall be maintained while finalizing the location of various switchboards.

Irrespective of the locations shown in the drawings, the switchboards shall be installed only after confirming the locations in consultation with the Consultant/Client. The switchboards shall be easily accessible to authorized persons.

9.12 OPERATING HEIGHTS

The maximum height of any operating handle/ knob/ button shall not be more than 1250 mm measured from the bottom of the board. The maximum height of the panel shall not exceed 2200m. As far as possible, all the indicating instruments shall be mounted at a height of not more than 1800mm measured from the bottom of the board.

9.13 CONTROL WIRING

All control wiring shall be carried out using 1100V grade, single core PVC wires with fine-stranded copper conductors. Following shall be the minimum sizes of copper conductor for control cables:

Voltage circuits - 1.5 Sq.mm

Current transformer circuits - 2.5 Sq.mm

The control wiring shall be segregated from wiring of differing voltages. Voltages transformer circuits and current transformer circuits shall be segregated.

The wiring shall be carried out using PVC wiring channels of required sizes. Where channels cannot be used, the wiring shall be neatly bunched and routed. Along the route, the wiring shall be supported at required intervals.

Adequate numbering by ferrules shall be provided for easy identification of the wires.

9.14 EARTHING

An earth bus of copper conductor shall be run across the full length of the board to which all the non-current carrying metal parts of the board shall be effectively earthed. The earth bus shall have facility at both ends for being connected to the external earthing system. Such points of connection on the earth bus shall be easily accessible. The size of the copper earth bus shall be 50x6mm unless otherwise specified.

9.15 LABELS

The board shall be labelled using plastic/Bakelite engraved designation label. 415V danger label as per relevant standard specification shall be affixed on the board.

The label bearing name of the board shall have a minimum width of 40mm. Every compartment shall be labelled for identification using labels of minimum width of 25mm. All indicating lamps, control switches, push buttons, etc; shall also be labelled for identification. Sizes, type and number of cables connected to each compartment shall also be mentioned in the label on the respective compartment.

All components such as current transformers, meters, contactors, etc. mounted inside the board shall be mounted in such a manner that their name plates are easily visible for reading. Name plate details of these components shall be fixed on the inside of the door/cover of the related compartment.

9.16 PACKING

The boards and their parts and components shall be packed to prevent any damage, deterioration or injury to them during transit. The packing shall be of weather-proof quality so that even if the packages are to be stored for comparatively long periods out of doors no damage or deterioration will be caused to the contents of the package. Adequate handling instructions shall be given on the packages. Movement of all internal parts shall be blocked by providing suitable transit packing's.

Makes- Schneider- Blok set, L&T Ti, ABB MNS, Siemens Siepan, Legrand XL3-DO

9.17 SCOPE:

The scope of work shall include:

i. Supplying, installation testing and commissioning of LT Panels
ii. Panel handling, loading unloading and storage.
iii. Associated inter panel and intra panel wirings including both ac and dc wirings as well as control cabling, from panel to panel and from panel to DB.

9.18 DEFINITIONS:

The definitions shall be as per IEC-61439 1& 2 and other relevant IEC standards.

9.19 CODES & STANDARDS:

The contractor is required to follow all relevant IS and IEC codes as per latest amendments, however in particular following codes may be applied in addition.

i. IS:8623-3 - Specification for Low-Voltage Switchgear and Control gears Assemblies
ii. IEC-60044 - Standard for instrument transformers.
iii. IEC-60099 - Standard for surge arrestor.
iv. IEC: 60255 - Measuring relays and protection equipment.
v. IEC -60947 - Low voltage switchgear and control gear.
vi. IS 2147 - Degrees of protection provided and enclosures for low voltage switchgear and control gear
vii. IS 375 - Marking and arrangement of bus bars.
viii. IS 13703-1993- HRC Fuse Links
ix. IS 2705- Current Transformer
x. IS 3231- Relay
xi. IS 1248- Indicating Instruments
xii. IS 722- Integrating Instruments
xiii. IS 6875- Control Switches & Push Buttons.
xiv. NEC- 2008 - National electrical code.
xv. NBC-2016 - National building code.
xvi. IER-1956: Indian electricity rules.
xvii. IEA-2007: Indian electricity act 2007
xviii. Any other local bye-law or supply company norm as applicable.

9.20 SERVICE CONDITIONS:

9.20.1 **System particulars:**

i. Nominal system voltage - 415V
ii. Rated system voltage - 1.1kV
iii. Frequency- 50Hz ±3%
iv. No. of phases- 3
v. System neutral- Solidly earthed
vi. Short circuit rating - 50kA for 1 sec

9.20.2 **Tolerances and creepage distance:**

Tolerances (on all the dimensions) and creepage distances shall be in accordance with provisions made in the relevant Indian/IEC/BIS standards and in these specifications. Otherwise the same will be governed by good engineering practice in conformity with required quality of the product.

9.21 SPECIFICATIONS:

9.21.1 **Panel Cubical Construction:**

i. The complete panel assembly shall be PTTA type.
ii. Panel fabricated out of 2mm CRCA sheet steel throughout and shall have undergone 7 tank process or better.
iii. Undrilled gland plates shall be 3mm thick. The gland plates shall have knock able type holes of suitable diameter of cable glands. Minimum 30% extra knock able holes shall be provided on

each gland plate. Non-magnetic gland plates shall be used where single core cables are used for three-phase supply.

iv. The panel shall be self-supporting, free standing or wall mounted.

v. The enclosure shall confirm to IP55 protection for outdoor panels and IP42 for indoor panels.

vi. The Panel shall be dust, vermin, corrosion proof and shall be mechanically stable to take the mechanical load of complete assembly with all fixed and moving components.

vii. The panel shall have appropriate protection against mechanical impact.

viii. The panel shall be extendable from both sides.

ix. The terminal blocks shall be provided at convenient location forcable termination. The distance between the terminal strip and gland plate shall be kept in such away that the cables can be properly dressed & no cable tension is transferred on the terminal strip/or equipment.

x. Proper grouting arrangement shall be made in panel for installation of panel in accordance with seismic requirement.

xi. Complete panel assembly shall be fixed on ISMC-100.

xii. The design shall ensure generous availability of space for ease of installation and maintenance of cabling, and adequate safety for working in one vertical section without coming into accidental contact with live parts.

xiii. Front and rear doors should be fitted with synthetic rubber or neoprene gaskets with fasteners designed to ensure proper compression of gaskets.

xiv. All sheet steel work forming the exterior of switch boards shall be smoothly finished, leveled and free from flaws. The corners should be rounded. The apparatus and circuits in the panels shall be so arranged as to facilitate their operation and maintenance and at the same time to ensure the necessary degree of safety.

xv. Panel shall be constructed in form-3b methodology.

xvi. All sheet steel work used in construction of panels shall be given for proper shot blasting/surface finish to make it free from all rusts/impurities/deposits.

xvii. It shall be then provided with two primer coat and then/powder coated (electro-statically) with final paint shade RAL7032 as per IS – 5.

xviii. It shall be the process of Powder Coating with suitable primer and having total coating thickness of 85-100 micron. The M.S Sheet Steel shall be given for proper shot blasting / surface finish to make it free from all impurities.

xix. All sheet steel work used in construction of panels should have undergone a rigorous metal treatment 7 tank process or better as mentioned below.

a. All sheet steel work shall be phosphate in accordance with the procedure in accordance with relevant standards for phosphatizing iron and steel. Oil, grease and dirt shall be thoroughly removed by emulsion cleaning.

b. Rust and scale shall be removed by pickling with dilute acid followed by washing with running water, rinsing with slightly alkaline hot water and drying.

c. A recognized phosphate process to facilitate durable coating of the paint on the metal surface and also to prevent the speared of rustling 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.

d. After phosphatizing through rinsing shall be carried out with clean water followed by final rinsing with dilute dichromate solution and oven drying.

e. Passivation in de oxalate solution to retain and augment the effects of phosphatizing.

9.21.2 **Busbars and internal connections:**

i. The selection, design and construction of bus bars shall conform to IS/IEC specifications and the latest amendments.

ii. Busbars shall be designed to carry rated currents during both steady state and transient conditions.

iii. The bus bars shall be air insulated and made of high conductivity, high Strength electrolytic grade aluminium.

iv. Bus bars shall be located in air-insulated enclosures and segregated from all other compartments of the cubicle.

v. Direct access or accidental contact with bus bars and primary connections shall not be possible.

vi. Bus bars shall be rated in accordance with service conditions and the rated for continuous and

short time current ratings specified in SLD / data sheets.

vii. Bus bars shall be design for a temperature rise as per IEC.

viii. Bus bars shall be adequately supported on SMC/DMC insulator supports to with stand thermal & electro dynamic stresses due to short circuit currents.

ix. Bus bar support insulators shall be of non-hygroscopic material and shall confirm to relevant IS standards.

x. The current density of the bus bars shall not be greater than 0.8 Amp / sq mm.

xi. Bus bars should be color coded for easy identification of individual phases and neutral.

xii. All the bus bars should be provided with color coded heat shrink sleeves.

xiii. A main horizontal aluminum grounding bus, rated to carry maximum fault current, extending along the entire of the panel shall be provided.

xiv. The ground bus shall be provided with two-bolt drilling with GI bolts and nuts at each end to receive the main Earthing grid.

xv. The size of the earth bus shall be as mentioned in drawings and schedules

xvi. Important parameters for complete panel assembly shall be as follows:

a. Voltage - 415V ± 6%
b. Frequency - 50hz ± 3%
c. No. of Phases - 3 + 100% Neutral + Earth bus
d. Peak Impulse Voltage – 8KV
e. Power frequency withstand capability - 2KV
f. Short circuit withstand capacity - 50kA for 1 second
g. Type of discrimination required among switchgears - Total discrimination
h. Min clearance and creepage distance - As per type test
i. Dimensions: As per approved type tested design.

xvii. Control wiring for all control circuit shall be done as follows:

a. Each control circuit shall be protected with the help of fuse in the phase and neutral shall be provided with suitable neutral links.
b. Control wiring shall be done with 1.1kV grade FRLS type control cables tested for power frequency withstand of 2kV.
c. All voltage circuits shall be wired with 1.5sqmm cu control cables.
d. All current circuits shall be wired with 2.5sqmm cu control cables.
e. Control wiring shall be done neatly with proper dressing and ferruling done.
f. Control wiring shall be color coded appropriately.
g. Terminal links used for control wiring shall be of good quality and shall withstand the temperature.
h. All connections must be tight.

xviii. Power wiring for main circuit shall be done as follows:

a. Switchgears of 100A rating and above shall be connected by the means of suitable busbars only.
b. Cable terminal blocks used for power cable termination shall be suitable to withstand the temperature rise due to steady state and transient currents.
c. All connections must be tight.

9.21.3 **Safety features and Interlocks:**

i. The safety shutter shall be provided in breaker panels, which shall prevent in advertent contact with isolating contacts when breaker is withdrawn from the Cradle.

ii. Door interlocking shall be provided in each switchgear compartment with a provision of defeat interlock.

iii. All panel doors shall have provision of padlocking.

iv. Insulating barriers shall be provided in all live sections of the panel.

v. There shall be provision of positive earth connection between fixed and moving portion of the ACB either through connector plug or sliding solid earth mechanism.

vi. Earthing bolts shall be provided on the cradle or body of fixed ACB.

vii. Arc chute covers shall be provided wherever necessary.

viii. In case of drawout type switchgears safety shutters shall be provided to fully cover the live section automatically once the switchgear is being draw out

ix. It shall be possible to bolt the draw-out frame not only in connected position but also in TEST and DISCONNECTED position to prevent dislocation due to vibration.

x. There shall be provision for locking the breaker in all three positions.

xi. The breaker shall be provided with interlock to prevent the breaker from being withdrawn or replaced except in the fully isolated position.

xii. Interlock shall also be provided to prevent the breaker from closing without in service position.

xiii. Space heaters triggered by thermostat shall be provided in cable compartments to avoid moisture.

xiv. Lamp operated with a door limit switch and a toggle switch shall also be provided in panel compartments along with 6/16A witch socket for ease of maintenance.

9.21.4 **Air Circuit Breaker (ACB):**

i. ACB shall be mechanically rugged and shall be designed to carry steady state current and transient current up to the time arc gets quenched.

ii. The moving parts of 4 pole circuit breakers shall have operating mechanisms, primary and secondary isolating devices, auxiliary switches, mechanical position indicators, all mounted on a rigid sturdy steel framework.

iii. Primary and secondary disconnecting devices shall be self-aligning types of fully isolation.

iv. On/Off push buttons shall be provided in ACB in such a way that ACB can be switched ON or OFF without opening the switchgear compartment. Breakers shall also trip without opening a switchgear compartment.

v. ACB shall be mounted on a cradle and shall be withdrawable type.

vi. The cradle shall be so designed and constructed as to permit the smooth withdrawal and insertion of the breaker into it.

vii. The movement shall be free from jerks, easy to operate and shall be on steel balls/rollers and not on flat surfaces.

viii. There shall be 3 distinct and separate positions of the circuit breaker on the cradle.

a. Service: Both main and secondary isolating contacts in service.
b. Test: Main isolating contacts separate and secondary isolating contacts in service.
c. Isolated: Both main and secondary isolating contacts in isolated.

ix. Both mechanical and electrical indications shall be provided for TEST and SERVICE position.

x. ACB maintenance trolley shall be provided by the contractor to rack out ACB

xi. ACB shall have following parameters / features:

a. Rated voltage - 440V
b. Rated frequency - 50Hz
c. P.I.V - 12kV
d. Rated short circuit capacity - 50kA for 1 sec.
e. Poles - Four pole
f. Temperature deration: No deration upto 50 degree celsius (In case deration is applicable, higher rating switchgear shall be provided)
g. Self watt loss: As per IEC-60947
h. Total breaking time: less than 70ms
i. Closing coil: suitable for 230V AC
j. Shunt coil: 24V DC through power pack
k. Drawout type: Electrical
l. Spring charge operation: Through 230V AC motor as well as through handle.
m. Antipumping feature: Required and shall be inbuilt.
n. Ics = Icu = Icw = 100%
o. Spare contacts required: 4NO + 4NC
p. Indications: On, Off, Trip, Spring Charge, Ready to close
q. Undervoltage coil: As per design requirement.
r. Time delay (td) - 0-400 m sec
s. Inbuilt thermal memory

xii. Release of ACB shall have following parameters / features:

a. Protections: L, S, I, G

b. Setting options: L - 40%-100% In (nominal current rating) = Ir
S - 2 x Ir to 10 x Ir
I - 6 x In to 12 x In
G - 10% ,20%, 50%, 100%

c. Release type: microprocessor based.

d. Zone selective interlocking - required.

e. Communication: Fully communicable and shall be equipped with RS-485 port.

f. Memory: Nonvolatile memory to record 10 trip histories and 10 alarm history.

g. Alarm and indications: Visual indications for % loading in each phase, L, S, I, G fault, release failure

h. Release shall be capable of generating remote alarm in case of any internal fault and Spare contacts shall be provided with release to do so.

9.21.5 **Moulded Case Circuit Breaker (MCCB):**

i. MCCB shall be mechanically rugged and shall be designed to carry steady state current and transient current up to the time arc gets quenched.

ii. MCCB shall be provided with door operating mechanisms having interlock, defeat and padlocking facility.

iii. MCCB should trip free, quick make and quick break type and should be equipped with a current limiting feature.

iv. MCCB shall have spreader links and terminal shroud as a feature for safety and proper heat dissipation.

v. MCCBs shall have double break mechanism.

vi. MCCB shall have following parameters / features:

a. Rated voltage - 440V

b. Rated frequency - 50Hz

c. P.I.V - 8kV

A. Rated short circuit capacity - 50kA (minimum) in Substation and 25KA minimum elsewhere

e. Poles - Four pole

f. Temperature deration: No deration upto 50 degree celsius (In case deration is applicable, higher rating switchgear shall be provided)

g. Self wattloss: As per IEC-60947

h. Total breaking time: less than 40ms

i. Shunt coil: suitable for 230V AC

j. Drawout type: Non withdrawable (fixed type)

k. Ics = Icu = 100%

o. Spare contacts required: 2NO + 2NC

p. Indications: On, Off, Trip

q. Undervoltage coil: As per design requirement

vii. Release of MCCB shall have following parameters / features:

a. Overload setting (L) 0.4-1 x In

b. Short circuit setting (with time delay) (S) 2 –10 x Ir

c. Time delay (td) 0-400 m sec

d. Short circuit setting (Instantaneous) (I) 11 x In

(Where In = nominal current of MCCB &Ir = rated current to which it is set.)

e. Ground Fault Setting with time delay (0-300ms) (G): 0.1-1 x In

f. Neutral setting (N) (wherever required): 0.5-1 x In

g. Release type: microprocessor based

h. Communication: Fully communicable and shall be equipped with RS-485 port.

i. Memory: Inbuilt thermal memory.

g. Alarm and indications: Visual indications for L, S, I, G fault

h. Release shall be capable of generating remote alarm in case of any internal fault and Spare contacts shall be provided with release to do so.

9.21.6 **Contactors:**

i. All contactors and bi-metal relays should conform to IS - 13947 - 4/IEC - 947-4 standards.
ii. Contactors should be suitable for requisite duty and the contactor shall be designed to operate even in severe operating conditions.
iii. The Contactors shall be suitable for switching and controlling squirrel cage and slipping motors as well as other AC loads such as solenoids, capacitors, lighting loads, heating loads and transformer loads.
iv. The contactors shall be suitable for operation in service temperature up to 50 degree C without de rating.
v. The contactors and bimetal relays shall have been tested for type-2 co-ordination at 50KA, 415 V 50 Hz as per IS 13947 for both fuse protected as well as fuse-less motor feeders.
vi. The contactor shall have coil of 220/240 V AC or as may be specifically asked for.
vii. The design of the current carrying parts, contact system and the magnet system should be such that it should increase reliability of electrical and mechanical endurance.
viii. Auxiliary contact should have double break parallel bridge contact mechanism. For operator safety the contactors above 45 Amp should have arc-chamber. The construction of the arc chamber should be such that there is no emission of arc by-products on the surrounding equipment.
ix. The contactor shall have funnel shaped cable entries, cable end stops and predetermined insertion depths.
x. Contactor below 63 Amp shall have captive screws preventing the screws from falling.
xi. Main contacts should be of silver alloy to have long contact life; it should withstand to keep the contact bounce to minimum and should be shrouded with an arc chute.
xii. Both moving and fixed contacts should be accessible for inspection or replacement without disturbing terminal wiring.
xiii. The magnet system should have laminated, construction to minimize the losses.
xiv. Coils should withstand high temperature and ensure low power consumption. Coil should be resin cast/encapsulated. It should have inter layer insulation.
xv. Contactor should have facility to mount add-on auxiliary contact block. Mechanical interlocks should be provided for sequential operations if required.
xvi. Contactor should be comfortably mounted in any position on a vertical plane. Contactor should be capable of handling high transient currents.
xvii. It's Insulation voltage level should be – 1000 v. Contactor shall be designed to have mechanical endurance of the order of minimum 15 million operations or better.
xviii. Contactor should operate without deration from - 30° C to +50°C

9.21.7 **Current Transformer:**

i. Current transformers shall comply with the requirements of IS. 2705.
ii. The current transformers shall be core type with cast resin/encapsulated secondary winding.
iii. CTs shall withstand stresses originated from short circuit for 1 sec. These shall be mounted on the switchboard stationary part.
iv. The secondary CT leads from all panels should be terminated on the front of the board on easily accessible shorting type terminal connectors so that operation and maintenance can be carried out when the panels are in service.
v. CT's shall be given heat run test.
vi. CT shall have following parameters / features:
    a. Rated voltage - 415V
    b. Rated frequency - 50Hz
    c. Class: 0.5 (for metering) / 5P10 for protection / PS for unit protection
    A. Rated short circuit capacity - As per fault level
    e. Construction - Ring / wound type
    f. Burden - As per SLD
    g. Rated secondary current: 5A

9.21.8 **Control switches:**

i. Control Switches shall be of the heavy-duty rotary type with escutcheon plates clearly marked to show the operating position.
ii. They shall be semi-flush mounting with only the front plate andoperating handle projecting.
iii. Circuit breaker control switches shall be of the spring return to neutral type, while instrument selector switches shall be of the stay-put type.

9.21.9 **Push Buttons:**

i. Push buttons should be of the momentary contact, push to actuate type.
ii. Push Buttons should be panel mounted, flush type having 22.5 mm Ø.
iii. Push Buttons should be spring returns type.
iv. Lock and key head with Push turn facility.
v. Modular blocks should contain NO-NC contact.
vi. It should be snap-fit type for easy assembly.
vii. Double break self-cleaning contacts for prolong life.
viii. NO-NC contact block should be colour coded for easy identification.
ix. Push Buttons should have transparent shroud and rubber shroud to enhance protection against ingress as per IP- 67.
x. It should withstand operating voltage as well as frequent operation.
xi. It should have finger proof shrouded terminals.

9.21.10 **Terminal Blocks:**

i. Insulating barriers shall be provided between adjacent terminals. CT Terminal blocks shall be shorting type.
ii. Terminal blocks shall have a minimum current rating of 10 Amps & 650 volt grade rating complete with insulated barriers. Provisions shall be made for label inscriptions.
iii. It should have snap fit action.
iv. It should have captive-screws and self-lifting washers.
v. Withstand temp range from –30° C to 100° C.
vi. Terminal Connectors should have flame retardant property confirming to UL-94, V-2.
vii. Terminal Block should be suitable for commonly used DIN Rail – 35 X7.5 mm and mounting channel 'C' shaped StA.32 mm.
viii. Terminal Block should be suitable for commonly used DIN Rail – 35 X7.5 mm and mounting channel 'C' shaped StA.32 mm.
ix. The construction material should be of high quality like polyamide 6/6 and contacts of Nickel plated brass. Labels shall be of anodized aluminum, with white engraving on black background.
x. They shall be properly secured with fasteners.

9.21.11 **Digital Energy Meter:**

i. The load manager shall be micro-controller based unit capable to measures a host of electrical parameters and display them on a 128 x 64 backlit LCA.
ii. It shall have load management feature and shall have six numbers of output relay contacts apart from CT/PT contacts.
iii. These outputs shall be individually field programmable for both the parameter on which to generate alarm as well as the values on which to activate alarm and deactivate it.
iv. In addition to this flexibility in terms of load management, the load manager shall also have RS485 port.
v. The unit shall be made for three phase four wire system. The installation type, CT ratios and PT ratios shall be site selectable.
vi. The Load Manager with its six relay contacts shall be capable to be used as a Demand Controller. The method of Demand calculation i.e. sliding window, fixed window shall be selected at site. The device shall have all the features needed to implement a robust electrical load management system.
vii. It shall be programmable / configurable to suit most control and communication needs. The load manager shall be capable to measure following parameters:
    1. Voltage (Volts L-N & L-L) VL-N Accuracy: 0.5% of Reading VL-L Accuracy: 1.0% of Reading.
    2. Current (Amps IR, IY, IB) Accuracy: 0.25% of Reading.
    3. Line Frequency 45 to 55 Hz, Accuracy: 0.3% of Reading.
    4. Active Power (P) Accuracy: 0.5% of Reading (For IPFI>0.5).
    5. Reactive Power (Q) Accuracy: 1.5% of Reading (Between 0.5 Lag to 0.8 Lead).
    6. Apparent Power (S) Accuracy: 0.5% of Reading.
    7. Power Factor for Individual phases and System. Accuracy: 0.5% of Reading (IPFI≥0.5) Range of Reading: 0.05 to 1.000 Lag/Lead.
    8. Total Active Energy (KWh) Range of Reading: 0 to 9999999.9 KWh Accuracy: Class 0.5 asper IS14697.
    9. Total Apparent Energy (KVAh) Range of Reading: 0 to 9999999.9 KVAh Accuracy: Class0.5 as per IS14697.

10. Total Reactive Energy (KVARh) Range of Reading: 0 to 9999999.9 KVARh Accuracy: Class 0.5
11. 3 rd to 15 thHarmonics (Odd) for all Voltages with THA.
12. 3 rd to 15 thHarmonics (Odd) for all Currents with THA.
13. Active Power (KW) Demand - Sliding & Fixed, Selectable.
14. Apparent Power (KVA) Demand - Sliding & Fixed, Selectable

viii. The device shall also have following features:
1. Display 128 X 64 Graphical LCD with Operating temp 10°C to 50°C.
2. Data Logging Buffer 2 MB, Non-volatile memory, capable of holding 19691 records Logging Duration Site selectable.
3. RS485 Modbus-RTU protocol
4. Communication USB 8.0 Pen-drive for downloading logged data

9.21.12 **Capacitor, Reactors, APFC relay**

i. Capacitor shall be self healing, heavy duty type MPPX.
ii. Capacitor shall be cylindrical type
iii. Rated voltage :525V
iv. Capacitor shall be capable of delivering the required kVAr at supply voltage
v. Heat dissipation of capacitors shall be managed properly.
vi. Capacitor Banks shall be suitable for Overloading as 115% for Over Current and 110% for Over Voltage. The Watt Loss shall not be less than 0.5w/kVAr.
vii. Capacitors shall be housed in sheet steel container to ensure the explosion free design. The external discharge resistors shall also be provided.
viii. All Capacitor Banks shall be controlled by TSM, which shall on/off the Capacitor Bank, accordingly these TSM should be suitable to handle the inrush current of capacitor Banks.
ix. Heat dissipation of TSM shall be managed properly.
x. 7% detuned reactor made up of copper shall be provided in series with capacitors.
xi. The APFC Relay shall be suitable for operation at 415V Power and Auxiliary both and 5A as current measurement. The Relay shall be of required stages (with at least 2 nos spare stages) to improve the P.F at least 0.99. The relay shall be microprocessor based with self-diagnostic and setting including C/K ration.

9.22 INSTALLATION, TESTING AND COMMISSIONING:

i. The complete Panel assembly shall be installed in accordance with the manufacturer's installation drawing duly approved by "The consultant "
ii. The panels need to be grouted considering the seismic zone requirement.
iii. Panels shall be properly aligned and the leveled within tolerance of +/- 2mm and shall be ensured with a water level indicator or a laser gun whichever available. No shim shall be allowed to make a panel level suitably.
iv. All live sections and compartments shall be covered with insulation barriers.
v. All the components of the panel shall be easily accessible.
vi. The location of installation shall be cleaned and co-ordination shall be made with other disciplines.
vii. Grouting holes shall be provided from inside and the panel shall be suitably and tightly bolted. No tuck welding with base channel is allowed
viii. Panels shall have peel-able poly layer on the cover for protection from cement, plaster, paints etc. during the construction period
ix. The holes made in enclosure for cable termination or anything else shall be made only through drill machine or approved cutting tool with marking of dia done prior to cutting or drilling. Extra left out holes shall be filled neatly with fire retardant sealant.
x. The Panel shall be tightly grouted No spare nuts-bolts shall be left out un-tightened / open inside the DB enclosure in any case.
xi. Gland plates where ever used for cable termination shall be tightly fixed and shall be earthed
xii. Size of Horizontal and vertical bus bars shall be equal.
xiii. Switchgears above 63A shall be mounted on bus bars tightly and accurately.
xiv. Termination lugs shall be tightly fixed and connected and there shall not be any bare wire

strand jetting out of the lugs. Suitable crimping tool shall be used and terminal wires shall be coved with heat shrinkable sleeves whose color coding has to match with the color of the wire used.

xv. Color coding shall be followed for internal wiring also in a similar pattern as described Bus bar shall be tagged for phase indication.

xvi. Panel compartments shall be provided with space heaters and lights operated by door limit switches.

xvii. The door of panel shall be aligned properly and there shall be no air gap left after closing the DB door. Gaskets shall be used to make DB free from moisture.

xviii. Panel shall have Padlocking arrangement and shall be pad locked after complete installation.

xix. Panel board shall be fully tested (both type and routine test) for its components as per the specification laid under Indian standards. In particular, following test shall be done:

(a) Continuity test (both earth continuity and loop continuity)

(b) Insulation resistance test.

(c) Contact resistance test.

(d) Primary injection test.

(e) Trip test and trip unit reset test with Test knob of breaker.

(f) CT testing (Polarity, Knee voltage)

(g) Phase rotation test.

(h) HV test on bus bar

(i) Space heater Testing

(j) Control wiring check

10. WIRING:

Note: Primarily specifications for wiring shall be followed. In case for some items/sections the same is not available CPWD specifications shall be followed. In case for some items/sections those are neither available in MES nor in CPWD. The following specifications shall be followed.

10.1 SCOPE:

The scope of this section comprises the supply, delivery, erection, testing and commissioning of following:

i. Wiring for power and UPS outlets, heavy duty sockets, and industrial plugs.
ii. Wiring from distribution boards to different switchboards and from there onwards to individual points like light points, Bell Buzzers, Fan points, small exhaust fan points etc for all internal areas.
iii. Switchboards, power plugs and its accessories like gang box, front plate, switches etc.
iv. Wires and its accessories like conduits, Outlet boxes, junction boxes, pull through boxes etc.
v. Ceiling rose, Connectors, Holders etc. for light points, Fan points, Bell buzzers, small exhaust fan points etc for all internal areas.
vi. Conduit/channel as the case may be, accessories for the same and wiring cables between the switch box and the point outlet, loop protective earthing of each fan/ light fixture.
vii. All fixing accessories such as clips, screws, Phil plug, raw plug etc. as required.
viii. Metal or PVC switch boxes (as specified) for control switches, regulators, sockets etc, recessed or surface type, and phenolic laminated sheet covers over the same.
ix. Control switch or MCB, as specified.
x. 3 pin and 6 pin socket, ceiling rose or connector as required. (2 pin and 5 pin socket outlet shall not be permitted.)
xi. Connections to ceiling rose, connector, socket outlet, lamp holder, switch etc.
xii. Bushed conduit or porcelain tubing where wiring cables pass through wall etc. However, in areas where false ceiling is provided, termination of wires should beat the fittings. Flexible conduits from ceiling junction box to the fittings shall be provided duly coupled at both ends. This shall be included within the scope of point wiring.)
xiii. Interconnecting wiring between switches within the switch box on the same circuit.
xiv. Any other related work as per Scope of work

10.2 CODES & STANDARD:

The relevant sections of Indian Standard Specifications as more particularly stated herein and broadly to all the codes, status and regulations as applicable shall be strictly enforced and adhered to. More particularly following codes should be strictly followed.

i. National Electrical Code - 2008
ii. National Building Code - 2016
iii. IS: 694 - Specification for PVC insulated cables for working voltage up to and including 1100 volts.
iv. IS: 732 - Code of practice for Electrical Wiring Installation.
v. IS: 8130 - Specification for Conductors for Insulated Electric Cables & Flexible cords. 6. IS: 9938 -Recommended Colors for PVC Insulation for LF Wires and Cables.
vi. IS: 3043 - Code Of Practice of Earthing.
vii. IS: 3202 - Climate proofing of Electrical Work.
viii. IS: 2509 of 1973 - Rigid non-metallic conduits for Electrical Work.

10.3 SPECIFICATIONS

10.3.1 HOUSE WIRES:

i. The wires shall be made from bright electrolytic annealed bare copper conductor with strands as specified under IS: 694.
ii. Solid conductor wires shall not be accepted.
iii. The wires shall be PVC (Poly vinyl chloride) insulated confirming to BIS specifications and shall be specified by the manufacturer for working voltage up to and including 1100 volts.
iv. The total gauge of wire shall be strictly in accordance with what has been specified in IS: 694.
v. The wires shall be FRLSH with appropriate and acceptable mechanical strength so that the insulation does not gets damaged while pulling these wires in conduit.

10.3.2 Thimbles/lugs:

i. The wires shall be terminated with the help of crimping lugs at both the terminals.
ii. These lugs shall be non-insulated made of tin plated copper, suitable for termination of 1.5 sqmm / 2.5 sqmm / 4 sqmm / 6 sqmm of copper wires.
iii. The lugs shall be suitable for 1100V and the min temperature rating for these lugs shall be 150 degree Celsius.
iv. The lugs shall be pin type with pin designed in such a fashion to prevent damage to the wire from over tightening and ensure a reliable electrical connection.
v. The lugs shall have good wire contact and good tensile strength. The lugs shall ensure quick and easy wire insertion.

10.3.3 Modular Base and cover plate:

i. The front plate shall have smooth surface from both the side and shall be properly matching the fixing alignment. Perfect alignment shall be maintained while fixing of the back boxes.
ii. The color shall be as per the architect’s directives.

10.3.4 Switch - Socket Outlets:

i. Wall receptacle (switch /sockets) outlets shall been closed type flush mounted made up of superior grade GE plastic polycarbonate with high mechanical electrical and thermal properties, suitable for 240 volts, 50Hz, ac.
ii. All switches socket outlets and fan regulators shall be fixed on metal strips which shall be screwed / welded to the box. All switches shall be in accordance with IS 3854:1997.
iii. The terminals and contacts shall be bimetallic silver contacts designed to withstand high overload conditions, high quality brass and copper contacts shall be used for fixed / moving contacts and there shall be a sufficient clearance of minimum 5mm between fixed and moving contacts to break the arc during switch operation.
iv. The terminals shall also be made from high quality brass. All sockets shall comply IS 1293: 2005.All receptacle outlets shall be shuttered type.
v. Three/Six pin Universal type sockets shall be used and these shall be mounted inside the switch boxes on adjustable flat M S strips / plates with tapped holes and brass machine screws, leaving ample space at the back and sides for accommodating wires.
vi. 5pin socket outlets will not be permitted. The third pin shall be connected to earth through protective (loop earthing) conductor. 2 pin or 5 pin sockets shall not be permitted to be used.
vii. Conductors connecting electrical appliances with socket outlets shall be of flexible type with an earthing conductor for connection to the earth terminal of plug and the metallic body of the electrical appliance.
viii. All such outlets shall be tested for an impact test value of 1NM, through a hammer stroke from a distance of 270mm from such outlets.
ix. The universal 6/16A sockets shall be capable to take the plugs for both 6A and 16A. No adapter shall be permitted.

10.3.5 Telephone Socket Outlets:

i. Telephone sockets used shall be RJ-11 suitable for all kind of telephones and cable to take both paired cable and CAT-7 / CAT6e / CAT-6 wires.

ii. The operating temperature for such receptacles shall be -20-degree C to + 60-degree C and IP20 rated.
iii. Master telephone outlets shall be equipped with surge protection devices and ringing capacitors.

10.3.6 **TV antenna socket outlet:**

i. TV sockets used shall be suitable for all kind of TV and coaxial cable to take relevant coaxial wires. The terminations shall be single screw type with fully enclosed PCBs with angled connectors provided. The operating temperature for such receptacles shall be -20- degree C to + 60-degree C and IP-20 rated.

10.3.7 **Electronic fan regulator:**

i. Step Type Electronic regulators should be used instead of resistance type regulators for controlling speed of fans. The fan regulator must be modular type with steps 1 to 5 for speed regulation of fan and another separate step for off. The fan regulator shall be engraved with good quality lettering showing the step range 1 to 5 and “OFF” step. The color shall be as per the architect’s directives.

10.3.8 **Industrial Socket:**

i. Industrial sockets shall comply to IEC: 60309.1.2002, with minimum IP rating of IP457 or specified otherwise in tender drawings.
ii. All such sockets shall be splash proof. However, where-ever specified in drawings these may be water sealed type sockets. The marking and dimensions shall be as per standards.
iii. The plugs shall be provided with suitable earthing terminal and electrical interlocking such that the lug doesn't comes out of the socket till the supply is there in plug.
iv. Accessories with earthing contact shall be provided with an earthing terminal. Metal-clad fixed accessories with an internal earthing terminal can, in addition, be provided with an external earthing terminal, which, except for flush type socket outlets, shall be visible from the outside.
v. Earthing contacts shall be directly and reliably connected to the earthing terminals, except that the earthing terminal of socket-outlets incorporated in the output circuit of an isolating transformer shall not be connected.
vi. Accessible metal parts of accessories with earthing contact, which may become live in the event of an insulation fault, shall be reliably connected to the internal earthing terminal(s) by construction.
vii. Accessories with enclosures of rubber or thermoplastic material, and parts of elastomeric such as sealing rings and gaskets, shall be sufficiently resistant to ageing. The construction of such Industrial plugs shall comply with IEC: 60309.1.2002. All such industrial plugs shall be suitable for 415V/240V, 3Phase/1Phase, 50Hz ac

10.3.9 **Modular GI Box:**

i. All the back boxes used shall be concealed GI type with loop in loop out holes marked which shall be removed at the time of jetting conduit inside the same.
ii. Size of such holes shall be suitable to take a 32mm diameter conduits. All such back box shall be made from pre-galvanized GI sheet metal with a wall thickness of 1.1mm and confirming to BS: 4662:2006.
iii. All such back box shall be provided with Brass Earth terminals and adjustable lugs. The metallic box shall be duly painted with anti-corrosive paint before erection. An earth terminal with stud and 2 metal washers and terminal block shall be provided in each back box for termination of protective conductors and for connection to socket outlet/metallic body of fan regulator etc.
iv. A metal strip shall be welded/screwed, to the metal box as support if tumbler type of control switches, sockets and/or fan regulators in flush pattern. Clear depth of the box shall not be less than 60 mm and this shall suitably to accommodate mounting of fan regulators in flush pattern.

10.3.10 **Switches:**

i. Wall receptacle (switch) shall be enclosed type flush mounted made up of superior grade GE plastic polycarbonate with high mechanical electrical and thermal properties, suitable for 240 volts, 50Hz, ac.
ii. All switches shall be fixed on metal strips which shall be screwed / welded to the box. All switches shall be in accordance with IS 3854:1997. The terminals and contacts shall be bimetallic silver contacts designed to withstand high overload conditions, high quality brass and copper contacts shall be used for fixed / moving contacts and there shall be a sufficient clearance of minimum 5mm between fixed and moving contacts to break the arc during switch operation. The terminals shall also be made from high quality brass.

iii. All such outlets shall be tested for an impact test value of 1NM, through a hammer stroke from a distance of 270mm from such outlets.

10.3.11 **Ceiling Fans:**

i. Fans shall be BEE 5 star rated Brusshless Direct Current Motor (BLDC). Ceiling fans including their suspension shall conform to relevant Indian Standards. The capacity of a ceiling fan to meet the requirement of a room with the longer dimension D meters should be about 55 D m3/min.

ii. The height of fan blades above the floor should be (3H + W)/4, where H is the height of the room, and W is the height of the work plane. The minimum distance between fan blades and the ceiling should be about 0.3 meters. Energy efficient fans with BEE 5-star rating or complying with IS 374: 1979, shall be used. The minimum service value of fans shall be 3.5 m3/min/W and air delivery 200 m3/min.

iii. All ceiling fans shall be wired to ceiling roses or to special connector boxes, and suspended from hooks or shackles, with insulators between hooks and suspension rods. There shall be no joint in the suspension rod. For wooden or steel joists and beams, the suspension shall consist of GI flat of size not less than 40 mm x 6 mm, secured on the sides of the joists or beams by means of two coach screws of size not less than 5 cm for each flat.

iv. Where there is space above the beam, a through-bolt of size not less than 1.5 cm dia, shall be placed above the beam from which the flats are suspended. In the latter case, the flats shall be secured from movements by means of another bolt and nut at the bottom of the beam. A hook consisting of in the case of ‘I’ beams, flats shall be shaped suitably to catch the flanges MS rod of size not less than 1.5 cm dia shall be inserted between the MS flat through oval holes on their sides. Alternatively, the flats may be bent inwards to hold tightly between them by means of a bolt and nut, a hook of ‘S’ form and shall be held together by means of a long bolt and nut for concrete roofs, a 12 mm dia.

v. MS rod in the shape of ‘U’ with their vertical legs bent horizontally at the top at least 19 cm on either side, and bound to the top of the roof shall be used. In buildings with concrete roofs having a low ceiling height, where the fan clamp cannot be used, or wherever specified, recessed type fan clamp inside metallic box, shall be used. Canopies on top of suspension rod shall effectively hide the suspension.

vi. The leading in wire shall be of nominal cross sectional area not less than 1.5sq. Mm. And shall be protected from abrasion. Unless otherwise specified, all ceiling fans shall be hung 2.75 m above the floor. The metallic body of regulators of ceiling fans shall be connected to earth by protective conductor.

11. DISTRIBUTION BOARDS

Note: Primarily specifications for distribution boards shall be followed. In case for some items/sections the same is not available CPWD specifications shall be followed. The following specifications shall be followed.

11.1 SCOPE:

The scope of this section comprises the supply, delivery, erection, testing and commissioning of following:

i. Distribution boards considered for all internal and common areas. This also includes items for switchgears used inside the distribution boards and its accessories.

ii. All internal wirings including neutral and earthing connections inside DB. This should however not include the earth connection from DB to earth pit.

iii. Complete Installation of distribution board in recess / surface as required.

iv. Dressing of Distribution board.

v. Testing and commissioning of distribution board in accordance with relevant IS standards.

vi. Tagging of each distribution board.

vii. Mounting of switchgear inside distribution boards. 8. Switchgears (MCCB/MCB) in existing cubical enclosure.

11.2 CODES AND STANDARDS:

The relevant sections of Indian Standard Specifications as more particularly stated herein and broadly to all the codes, status and regulations as applicable shall be strictly enforced and adhered to. More particularly following codes should be strictly followed.

i. National Electrical Code - 2008

ii. National Building Code - 2016

iii. IS 8623:1977 - Distribution boards

iv. IS 2675: 1983 - Enclosed distribution fuse boards and cutouts for voltages not exceeding 1000 V Ac and 1200 V Dc

v. IEC 439-3 IEC for Distribution boards up to 250A with door

vi. BS EN 60439-3 -Low-Voltage Switchgear and Control Gear Assemblies.

11.3 SPECIFICATIONS:

11.3.1 **Distribution Board (DB):**

i. Distribution board shall be made up of sheet steel thickness of minimum 2mm with powder coating, completely dust / vermin / corrosion free with ingress protection rating of IP 43.

ii. The board shall have adequate space for termination of incoming and outgoing cables.

iii. Removable un-drilled top & bottom gland plates, should be suitable for wall, column mounting type B. The distribution shall be double door type with provision of front operated, fully lockable, hinged door. The distribution boards shall have protection against mechanical impact index of minimum IK08.

iv. Neoprene gasket, shall be provided to make distribution box air tight and free from moisture. Inner door shall be fixed up with screws with cutouts for MCB operation. Each such distribution board shall have din rails for mounting switchgears those shall be made up of galvanized steel, passivized with a thick layer.

v. The ampere ratings of these din rails shall typically be 1.5 times the full load current carrying capacity of the mounting switchgear. The dimensions shall be so selected so that

the switchgear gets easily and tightly mounted in the din rail. The distribution board shall have neutral bars of current rating equivalent to phase bars for each phase. Neutral bars of individual phases shall be isolated with each other so that leakage on any one phase doesn't affect the other healthy phases.

vi. The clearances among various components inside the distribution board shall comply with mentioned codes and standards. Each neutral bar shall have tinned plated bolts to terminate neutrals of respective circuits to the neutral bar and each neutral bar of respective phase shall be provided with arc flash insulating covers. Terminal blocks shall be suitable for termination of conductor/ cable of required size but minimum rated cross section of the terminal blocks should be 6 sq. mm.
vii. Terminal block shall be made of flame retardant polyamide material. Color terminal blocks and FRLS wires for easy identification of RYB Phases, Neutral and Earth. DB shall be provided with a detachable cassette for safe removal of MCBs, RCCBs. Detachable plate with Knock out holes shall be provided at the top/ bottom of board. Copper bus-bar of at least 1.5 times the rating of incomer MCB / MCCB, along with, neutral bars, earth bars. Board shall be suitable for operation on 3 Phase / single phase, 400 / 240 volts, 50 cycles, 4 wire system, with neutral grounded at transformer.
viii. The selection, design and construction of bus bars shall conform to IS specifications and the latest amendments. The bus bars shall be air insulated and made of high conductivity, high strength cu. Bus bars. Direct access or accidental contact with bus bars and primary connections shall not be possible. Bus bars shall be rated in accordance with service conditions and the rated for continuous and short time current ratings specified in SLD / data sheets.
ix. Maximum temperature of the bus bar and bus bar connections, under operating conditions, while carrying rated normal current at rated frequency shall not exceed 85 degree C.

11.3.2 **Switchgear (MCB/RCCB/RCBO):**

i. MCB should be trip free, quick make and quick break type MCB should be suitable for interchangeable line/ load connections. The MCB shall have minimum 10 KA breaking capacity with (Ics=Icu=10kA), where Ics is service breaking capacity and Icu is ultimate breaking capacity defined as per IS13947. MCBs shall have ISI mark as per IS8828-1996 (IEC60898).
ii. The MCB shall be suitable for temperature up to 50 deg C without de-rating. All outgoing feeder MCB shall be provided with clip on type auxiliary contact to interface. of MCB shall be provided with insulated separators between the phases and also on both end. The size and design of the terminal should be adequate to accommodate aluminum/ copper cable required for the rated current of the MCB. It should confirm to current limiting principle class –3 to ensure extremely low let through energy (I^2t) under fault conditions.
iii. It should have 'two position' DIN clip ensuring easy mounting and removal. It should confirm C.E. Marking (confirmation to European standards), based upon the tripping characteristics the MCB shall be described as B, C or D curves and the same must be mentioned in bold upon the MCB. All MCB shall have a mention of Full load current, short circuit current, utility voltage, frequency, tripping characteristics (B, C, and D), basic 3 line diagram. The poles of MCBs shall have minimum self-resistance as per latest IEC standards.
iv. The RCCB shall have sensitivities of 30mA and 100mA as specified in the design drawing or SLD or BOQ. The RCCB shall comprise of a core balance current transformer built in to calibrate the differential current between any phase and neutral.
v. The RCCB shall have a mention of its sensitivities engraved upon it. Residual current break over shall be rated for overload, short circuit as well as earth leakage and shall be capable to provide protection against all three of these fault conditions.
vi. The RCBO shall be quick make quick break type. It should confirm to current limiting principle class –3 to ensure extremely low let through energy (I^2t) under fault conditions. It should have 'two position' DIN clip ensuring easy mounting and removal.

12. FIXTURES & FANS

12.1 SCOPE:

The scope of this section comprises the supply, delivery, erection, testing and commissioning of following:

i. Lighting fixtures, external lighting, Ceiling fans, Exhaust fans and wall fans.
ii. Supply, Installation, storage, safety, security and handling of above fixtures.

Note: The Contractor is required to submit detailed lighting design as per lux level requirements mentioned in the specifications and NBC-2016. Light fixtures shall be as per MES.
A fixture schedule needs to be prepared by the contractor, in required format with technical details and the same shall be approved by the consultant.

12.2 SPECIFICATIONS:

12.2.1 **Internal:**

i. The light fixtures and fittings shall be assembled and installed complete and ready for service, in accordance with details, drawings, manufacturer's instructions and to the satisfaction of the Project Manager.

ii. Light fixtures shall be LED type, factory wired with FRLSH wires and inbuilt surge arresters.

iii. Light fixture shall confirm to suitable IP rating.

iv. Color temperature shall be as per Architect/MES.

v. CRI shall be >80 and THD <=10%

vi. Efficiency shall be > =110 lumens per watt

vii. All fixtures shall be BIS certified and R code of the fixture shall be furnished.

viii. LM79, LM 80 and other photometry reports shall be required.

ix. Drivers shall be electronic type; dimmable drivers shall be used in areas where dimming is required. Drivers shall have pf >= 0.98

x. Lights shall have proper diffuser.

xi. Wires brought out from junction boxes shall be encased in metallic flexible pipes for connecting to fixtures concealed in suspended ceiling. The flexible pipes shall be provided with a checknut at the fixture end.

xii. Down lighter fixtures specified with overall lengths are subject to change and shall be checked with conditions of the job and installed as directed.

xiii. All suspended fixtures shall be mounted rigid and fixed in position in accordance with drawings, instructions and to the approval of the Project Manager.

xiv. Fixtures shall be suspended true to alignment, plumb, level and capable of resisting all lateral and vertical forces and shall be fixed as required.

xv. All suspended light fixtures etc. shall be provided with concealed suspension arrangement in the concrete slab/roof members. It is the duty of the Contractor to make these provisions at the appropriate stage of construction.

xvi. All switch and outlet boxes shall be bonded to earth with insulated stranded copper wire as specified.

xvii. Wires shall be connected to all fixtures through connector blocks.

xviii. Flexible pipes, wherever used, shall be of make and quality approved by the Project Manager

xix. The wall fan shall be provided with aluminum sturdy blades that deliver air displacement less than or equal to 5500 cubic meter/hour. Fan motor shall be powerful, energy efficient, rated at >=100W, delivers a top speed of 1500-2000 rpm. The fan shall have sturdy spiral mesh guard, which, besides being functional, adds to the overall beauty and reliability of the design. The mesh shall be easy to clean and maintain. The fan must have features of speed control options for an optimum airflow that is sure to transform the place where you install it. The fan shall have double ball bearing head to ensure a 90 degree oscillation that helps it to cover all the area within its reach.

xx. Exhaust fans propeller type shall be provided in Substation, Panel rooms, all toilets and kitchen areas.

12.2.2 **Street / Road Lighting**

i. Street Lights, Road Lighting, Parking and Area lighting shall be provided as per codal & functional requirements.

ii. Suitable LED type luminaire with inbuilt harmonic suppression mechanism, IP-66 protection, shall only be used for external area illumination. All LED luminaire shall be LM79, LM80 tested from NABL accredited govt lab and Test-Reports shall be made available to the Engineer-in-charge. The external lighting shall be fed from outdoor type feeder panels and automatically controlled through 24-hour Digital/ Astronomical Timers.

iii. Scope of work of street lighting shall be for all internal roads and nearby areas

iv. Work of providing street lighting shall be done by the agency as per street Lighting Standards for world class lighting (Revision I) approved by the client. Relevant detail for street lighting standard is given in DBR for ready reference. Layout plan shall be got approved from Engineer- in – charge and as per detail given below:

v. Incoming cable from sub-station / source of supply to street lighting main feeder pillar shall subsequently feed to feeder pillars located at different locations for street lighting.

vi. These feeder pillars shall be fabricated as per typical drawing and technical specification. Moulded case circuit Breaker (MCCB) as incomer and MCBs for outgoing circuits, AC contactor, Time switch (Programmable) and bus-bars shall be provided in the feeder pillar, provision shall also be kept for providing Energy Meter inside the feeder pillar. Electrical single line diagram of feeder pillar shall be got approved from Engineer-in-charge.

vii. Two core XLPE aluminium conductor armoured cable of 2C x 16sq. mm (minimum) for pole to pole & 4 core of suitable size to energize the feeder pillars shall be used and laid through DWC pipe throughout the entire work.

viii. Pole height, single or double arm bracket, wattage of the luminaries, lux level etc. shall be decided as per Street Lighting Standards. To ascertained actual Lux level, three nos. pole shall be erected and luminaire installed for each category of roads , then illumination is checked for desired Lux Level considering maintenance factor before execution of street lighting work, for approval of scheme/wattage of luminaire etc. by the Engineer-in-Charge.

ix. Street Lighting fixtures shall be LED type made of high pressure die- cast Aluminium housing single piece in construction with IP-66 protection.

x. Independent circuits shall be provided to alternate poles so that one circuit can be switch off the lights automatically during night time to save energy.

xi. Street / Road lighting poles shall be octagonal type GI (Hot dip galvanized as per BS EN ISO 1461 Standard 70 Microns) with welded base plate and with inbuilt cable loop in box 500mm length (Box height). Street / Road lighting poles shall be mounted on precast RCC foundation of minimum 600x600x1200(D) with suitable reinforcement (Foundation bolt EN 8 grade). Octagonal pole shall be designed to withstand the maximum wind speed as per IS 875. The top loading i.e. area & the weight are to be considered to calculated maximum deflection of the pole and same shall meet the requirement of BSES 40-3-3-:2003. Pole shall be HT Steel conforming to grade S 355 & base plate fe 410 confirming to IS 2062, & Bracket ERW tube as per IS 1161.

xii. The street lighting scheme prepared on the above lines shall be got approved from Engineer-in-charge (Electrical) before execution. Layout shall be made in such a manner that metering is done at one / two points only.

xiii. Landscape lighting shall be as per the approved landscape scheme.

xiv. Standalone type solar lights shall be used for street lighting strategically.

13. SOLAR PV SYSTEM (40KW grid tie)

The PV power project developers will provide a copy of the type test certificate(s)/ report(s) with the bid and routine type reports before the dispatch of the equipment.

The Solar PV system shall consist of following equipment:

i. Solar PV modules consist of the required number of PV cells.
ii. Power Conditioning Unit/ String Inverters with SCADA Compatible
iii. Mounting structures
iv. Cables and hardware
v. Junction box and distribution boxes
vi. Earthing kit
vii. Lightning arrestors
viii. PVC pipes and accessories
ix. Toolkit
x. Civil pedestals
xi. Solar panel cleaning arrangement with water pumps and pipelines
xii. Spares for 2 years

13.1 Duty Cycle

Average Hours of Operation/day: 8-10 hrs per day, as per insolation levels of the site.

13.2 PV ARRAYS

The PV modules convert the light reaching them into DC power. The amount of power they produce is roughly proportional to the intensity and the angle of the light reaching them. They are therefore required to be positioned to take maximum advantage of available sunlight within siting constraints. Supplier will position the PV modules in such a manner that the maximum power is obtained with the sun's movements during the day.

Supplier shall follow the latest engineering practice; ensure long-term compatibility requirements and continuity of equipment supply and the safety of the operating staff.

The PV power project developers are required to optimize generation of electricity in terms of kWh generated per kWp of PV capacity installed vs available solar radiation at the site (may be obtained through use of efficient electronics, lower cable losses, maximization of power transfer from PV modules to electronics and the grid, maximization of power generation by enhancing incident radiation by optional methods like seasonally changing tilt angles etc).

The PV system shall support remote monitoring of important parameters. The system shall be designed such that personnel without any background knowledge in Microprocessor-based technology are able to operate the system. The operator interface shall be intuitive such that operating personnel shall be able to operate the system easily after having received some basic training.

The SPV cells shall be manufactured using unique highly efficient diffusion process or any other technology in vogue so as to ensure uniform diffusion profiler to achieve close spread and higher efficiency for each cell.

Stabilized net output of the Solar PV Array for the Solar Power System should not be less than the Nominal design level for the System under Standard Test Condition.

Each solar PV module shall be warranted by the manufacturer for at least 90% of its rated power for 25 years from the date of system acceptance.

Photo electrical conversion efficiency of GTRTSPVS module shall not be less than 15%. The bidder shall indicate minimum module efficiency.

Fill factor of the module shall not be less than 0.80.

The bidder shall provide the sample solar PV module electrical characteristics including current- voltage (I-V) performance curves and temperature coefficients of power, voltage and current. However, the tabulated document with all the relevant data like voltage, current, power output for all the modules also to be provided.

The PV modules shall be suitable for continuous outdoor use

The PV module shall be made of high quality laminated in ultra violet stabilized polymer material such as Ethyl Vinyl Accelerate (EVA), Tedler, and toughened class. The size of single crystalline silicon PV cells shall be so chosen so as to maximize energy density and align with economies of scale.

PV module shall be provided with frame of anodized channels for size and simplicity in installation offered as a single module or series parallel combination of modules. The PV module shall be provided with screen-less frame with solar cable and connector.

The PV modules shall be equipped with bypass diode to minimize power drop caused by shade.

The PV modules shall be made of light weight cells, resistant to abrasion, hail impact, rain, water and environmental pollution. The PV modules shall be provided with anti-reflection coating and back surface field (BSF) structure to increase conversion efficiency.

The PV module shall use lead wire with weatherproof connector for output terminal.

The power output of the PV system under Standard Test Conditions (STC) should be 40kWp made of min. 540-580 Wp or any other module size depending upon manufacturer prudent practice. With nominal output voltage of 24 V. The number of modules to be supplied shall be worked out accordingly. The operating voltage corresponding to the power output mentioned above should be 35.2 V for 24Vsystem.

The terminal box on the module should have a provision for opening for replacing the cable, if required.

A strip containing the following details should be laminated inside the module as to be clearly visible from the front side:

a) Name of the Bidder or distinctive Logo
b) Model or Type No.
c) Serial No.
d) Year of make.

The GTRTSPVS shall perform satisfactorily in relative humidity up to 85% and temperature between -10ºC to + 86º

13.3 String Inverter (SCADA Compatible)

The DC power produced is fed to inverter for conversion into AC. In a grid interactive system AC power shall be fed to the grid at three phase 415 AC bus. Power generated from the solar system during the daytime is utilized fully by powering the building loads and feeding excess power to the grid as long as grid is available. In cases, where solar power is not sufficient due to more demand or cloud cover etc. the building loads shall be served by drawing power from the grid. The inverter should always give preference to the Solar Power and will use Grid power only when the Solar Power is insufficient to meet the load requirement. The inverter shall be 3Phase type which shall convert dc output from solar PV to three phase AC output.

The output of the inverter must synchronize automatically its AC output to the exact AC voltage and frequency of the grid. Inverter shall continuously monitor the condition of the grid and in the event of grid failure; the inverter automatically switches to off-grid supply within 20- 50milliseconds. The solar system is resynchronized with the grid within two minutes after the restoration of grid.

Grid voltage shall also be continuously monitored and in the event of voltage going below a preset value and above a preset value, the solar system shall be disconnected from the grid within the set time. Both over voltage and under voltage relays shall have adjustable voltage (50% to 130%) and time settings (0 to 5 seconds). Min efficiency shall be 95%.

Metal Oxide Varistors (MOVs) Surge protectors shall also be provided on DC and AC side of the inverter. Dc loading ratio shall be 1:1. Inverter shall have anti islanding feature.

The inverter control unit shall be so designed so as to operate the PV system near its maximum Power Point (MPP), the operating point where the combined values of the current and voltage of the solar modules result in a maximum power output.

Following specifications shall be provided by the OEM.

Continuous output power rating	
Nominal AC output voltage and	
frequency	
Accuracy of AC voltage control	
Output frequency	
Accuracy of frequency control	
Grid Frequency Control range	
Maximum Input DC Voltage	
MPPT Range	
Ambient temperature	
Humidity	
Protection of Enclosure	
Grid Voltage tolerance	
Power factor control	
No-load losses	
Inverter efficiency(minimum)	

Liquid crystal display shall at least be provided on the String inverters front panel or on separate data logging/display device to display following

- DC InputVoltage
- DC Inputcurrent
- AC Poweroutput(kW)
- Current time anddate
- Timeactive

- Time disabled
- Time Idle
- Temperatures(C)
- Converterstatus

Protective function limits (VIZ-AC over voltage, AC under voltage, over frequency, under frequency, ground fault, PV starting voltage, PV stopping voltage, over voltage delay, under voltage delay over frequency, ground fault delay, PV starting delay, PV stopping delay.) shall also be displayed. Nuts & bolts and the inverter enclosure shall have to be adequately protected taking into consideration the atmosphere and weather prevailing in the area. Dimension and weight of the inverter shall be indicated by the bidder in the offer. All doors, covers, panels and cable exists shall be gasketed or otherwise designed to limit the entry of dust and moisture. All doors shall be equipped withlocks.

Solar PV systems shall be provided with synchronizing equipment having three input for comparison i.e. grid supply vs. solar output, Generator output vs solar output so as to connect the SPV systems in synchronism with grid or Generator. In case of grid failure, solar PV system shall be disconnected from the grid and out of synchronization for a period Generator supply is not restored. PV system shall be synchronized with the GENERATOR supply after Generator is started.

13.4 Protection and Control

PV system software and control system shall be equipped with islanding protection as

described above. In addition to disconnection from the grid (islanding protection i.e. on no supply), under and over voltage conditions, PV systems shall be provided with adequate rating fuses, fuses on inverter input side (DC) as well as output side (AC) side for overload and short circuit protection and disconnecting switches to isolate the DC and AC system for maintenances are needed. Fuses of adequate rating shall also be provided in each solar array module to protect them against short circuit. A manual disconnect switch beside automatic disconnection to grid would have to be provided at utility end to isolate the grid connection by the utility personal to carry out any maintenance. This switch shall be locked by the utility personal.

13.5 Other requirements

EPC contractor needs to provide

- PV syst calculation to assess the performance ratio.
- Shadow analysis to be done.
- Drawings showing plan and elevations for solar panels.
- Single line diagrams.
- STADD modelling for structure safety
- Product data for each component.
- Earthing and lightinng protection arrangement.

13.6 ADDITIONAL INFORMATION

i. All techno commercial terms and conditions for substation shall be as per MES specifications for Substation works.
ii. For DG, MES specifications for DG works shall be followed.
iii. For lighting, grounding, FAPA, cable management, lightning protection, internal power distribution IEI specifications to be referred.
iv. All techno commercial terms and conditions shall be as per MES.
v. For indicative UPS point information tender drawings / Inventories in internal electrical installation to be referred.

14. UPS SYSTEM:

14.1 DEFINITIONS:

The definitions shall be as per relevant IEC/IEEE standards.

14.2 CODES & STANDARDS:

The contractor is required to follow all relevant IS and IEC codes as per latest amendments, however in particular following codes may be applied in addition.

i. IEEE Standard 446-1987: Emergency and standby power systems.
ii. IEC 146: Performance testing of UPS.
iii. ANSI C 37.90a, IEEE Standard 472: Surge withstand capability test.
iv. ANSI C 34.2: Practices and requirements for semiconductor power rectifiers.
v. ANSI C 34.2: Practices and requirements for semiconductor power rectifiers.
vi. ANSI C 37.90: Relays and relay system associated with electrical power apparatus.
vii. IS 2208 & IS 9224: Cartridge fuses for voltages up to and including (Part 1&2) (IEC 269) 650 V.
viii. IS 9224 (Part - 4): Fuses for protection of semiconductors.
ix. BS 2709 (I.E.C 119): The Electrical Performance of Semiconductor Rectifiers. (Metal Rectifiers)
x. BS 4417 (I.E.C 146): Semi-conductor Rectifier Equipment.
xi. IS 1652 & IS 1652: Lead-acid stationary cells and batteries.
xii. NEC- 2008 - National electrical code.
xiii. NBC-2016 - National building code.
xiv. IER-1956: Indian electricity rules.
xv. IEA-2007: Indian electricity act 2007.
xvi. Any other local bye-law or supply company norm as applicable.

14.3 SERVICE CONDITION:

14.3.1 **System Particulars:**

i. Nominal system voltage - 415V /240V
ii. Rated system voltage - 1.1kV
iii. Frequency- 50Hz ±3%
iv. No. of phases– 3P/1P + neutral + Integrated earth
v. System neutral- Solidly earthed
vi. Short circuit rating – as per calculated fault on LV side.

14.3.2 **Tolerances and creepage distance**

Tolerances (on all the dimensions) and creepage distances shall be in accordance with provisions made in the relevant Indian/IEC/BIS standards and in these specifications. Otherwise, the same will be governed by good engineering practice in conformity with the required quality of the product.

14.4 SPECIFICATIONS:

14.4.1 **General:**

i. The UPS system should be microprocessor based and so carefully designed to maximize the availability of power for critical loads and to ensure that equipment's is protected to the extent possible against power failure and quality problems.

ii. The UPS system shall constitute of (but not limited to) the following:
   a. Transient Voltage surge suppression (TVSS)
   b. Rectifier
   c. Inverter
   d. Static bypass switch
   e. Manual / Maintenance bypass switch
   f. Display Panel
   g. Control Logic
   h. Isolation Transformer
   i. Battery Monitoring system
   j. Temperature compensating battery charging

k. Audible Alarm
l. SMF Battery Bank

iii. All components of the UPS equipment shall have surge withstand capability (SWC) to meet the requirements of ANSI C 37.90a, IEEE Standard 472-1974.
iv. All components of UPS system shall withstand short circuit current without any damage.
v. Fuses shall not be longer than 125% of the transformer primary circuit current where the secondary circuit fuse protection has not been provided where the secondary fuses are sized not greater than 125% of the secondary current of the transformer, fuses shall not be required in the primary circuit, provided the primary feeder fuses are not larger than 250% of the transformer primary current.
vi. All the neutral conductors in three phase UPS systems shall be sized equal to at least 200% of the maximum phase current. In addition, all the isolators and circuit breakers used in three phase UPS system shall also to be rated such that the neutral poles shall take at least 200% of the maximum phase current.
vii. All control shall be designed and positioned such that possibilities of inadvertent or accidental operations are eliminated.
viii. All UPS system cabinets, frames and power equipment shall be double earthed.
ix. The various overload capacities of inverters, static switch, step down transformer/voltage stabilizer as specified herein are the minimum requirements. However, if the firm's offered system has better overload capacities for the above devices, the same shall be highlighted by the bidder in his bid.
x. Maximum humming noise level of UPS shall be 75 dB one meter away from the UPS cabinets.
xi. The system shall be fully microprocessor based
xii. The system shall be on line double conversion i.e. load independent from both main's voltage and frequency. Ensure server-grade high quality of power.
xiii. The system shall have IGBT based PWM inverter resulting perfect sine wave voltage.
xiv. The system should be wide input voltage tolerance (+10/-10%).
xv. The system should be wide input frequency tolerance (+ / - 6%)
xvi. The system shall be advance battery management system with programmable automatic battery testing, constantly monitors the health of the battery pack keeping the battery ready to work for emergency situations.
xvii. The system shall be high overload capacity of static bypass (10 times for 100ms.)
xviii. The system shall be built in maintenance bypass.
xix. Front access shall be provided for easy replacement and maintenance.
xx. The system shall have overload capacity:
a. Below 105% rated output current, continuous operation
b. 105% ~ 125% UPS output current, 5 minutes
c. 125% ~ 150% UPS output current, 1 minute
xxi. The system shall have selectable timer.
xxii. The system shall have adjustable frequency synchronization window upto +/-1% in the static bypass.
xxiii. The system shall have hardware for fault diagnostic unit, data logger and power monitoring system.
xxiv. The system shall have comprehensive display panel having three functional sections such as
a. Mimic: LED Display indicates the status of UPS.
b. Control: Touch membrane switches for ON, OFF, RESET, audible alarm and STOP functions.
c. Display: LCD display indicates operating parameters and alarm conditions.
xxv. Each UPS shall give regulated filtered & uninterruptible power supply as described in the specifications.
xxvi. In case the calculated /specified UPS capacity is not the same as one of the standard KVA ratings of the UPS manufacturer, the next higher standard KVA rating shall be selected. UPS of non standard rating shall not be acceptable.
xxvii. UPS system supplied shall be the latest state of the art technology system fully digitalized using microprocessor controlled, IGBT based full wave rectification and IGBT inverter.
xxviii. Batteries shall be valve regulated lead acid specially meant for UPS application.
xxix. Monitoring and control system shall also be state of the art technology LCD touch panel type providing all relevant data described in this document.
xxx. The monitoring and control system shall be capable of RS485 input software for connecting to customer's computer system for data display and monitoring.
xxxi. All necessary components required for protecting UPS equipment and connected inputs and outputs shall be furnished as an integral part of the UPS system.

xxxii. The UPS systems shall include but not be limited to the following equipment:
   a. UPS system including 100% capacity float-cum-boost charger with 100% sealed valve regulated lead acid batteries with guaranteed battery life of 5years.
   b. Suitable factory built battery cabinet for housing the batteries, including terminal isolator / breaker and power disconnect device.
   c. All cables, connectors, accessories like trunking, cable trays, conduits etc. required for connection between battery and the UPS unit.

14.4.2 **Rectifier:**

i. The static converter (rectifier) shall be a multi-functional converter providing functions of power conversion, battery charging and shall have the additional functions of input power factor improvement and current harmonics reduction.

ii. The rectifier shall be a solid state, IGBT based, static PWM converter utilizing Intelligent Power Module (IPM) and shall include intelligent features like the drive circuitry, over current protection, over temperature protection, control power failure protection and short circuit protection. The IPM transistors shall enable high speed switching at 6 KHz thus reducing the heat dissipation in the UPS and thereby providing high efficiency. The PWM converter shall utilize the above and achieve unity power factor and reduce input current harmonics as given earlier and thus improve the overall power factor of the converter achieving input KVA savings. During any step inverter load change (0-100%) the converter shall only supply 100% current to the inverter.

iii. The rectifier equipment shall include all necessary control circuitry and device to conform requirements like voltage regulation, current limiting, wave shaping, transient recovery, automatic synchronization etc.

iv. The rectifier logic shall provide input current limiting by limiting the DC output current. Two (2) line side current transformers shall be employed as a means of sensing the current amplitude. The rectifier shall be capable of supplying overload current in excess to the full load rating. The DC output current limit values shall be as follows:
   a. Rectifier output current (maximum) 100%
   b. Rectifier output current (aux.) 25% - 100% variable.

Note: 100% current shall be under the battery recharging mode.

v. The rectifier logic shall provide current limiting function of battery charging to prevent the battery from damage. The following battery current limit and protection shall be provided.
   a. Battery charge current limit 10% of battery Ah rate.
   b. Over-current protection at 120% of above item.

vi. The rectifier / charger output voltage shall not deviate by more than +/- 1% of the nominal output voltage, due to the following conditions:
   a. From 0 to 100% loading.
   b. Rectifier input variations of voltage and frequency within the limitations
   c. Environmental condition variations

vii. The rectifier logic shall employ circuitry to allow a delayed and timed ramping of input current. Subsequent to energizing the rectifier input, the ramping of current shall be delayed by a maximum of 3 seconds. Upon starting the walk-in process, the ramping of current is timed to assume the load gradually within 1 through 60 seconds (every 1 second selectable).

viii. The A/C input fuses shall be provided at the rectifier input as a means of overload protection. The AC maximum current shall be controlled by the rectifier.

ix. During any step inverter load change (0-100%), only the rectifier shall supply 100% current to the inverter.

x. The rectifier shall be suitable to be fed from the normal power supply source.

xi. Basic parameters of rectifier shall be as follows:
   a. Nominal Voltage: 415V, 3 Phase / 240V 1 phase
   b. Voltage Range.: + 10 % / - 10% AC
   c. Frequency Range: + 6 % / - 6% AC
   d. Input Power Factor: 0.98 lagging or more at full load (PF improvement)
   e. Input Harmonic Current THD: 7% typical at 100% load 6% maximum at 50% load
   f. Duty: Continuous
   g. Cooling: Forced cooling using fans with thermal relays using a latched cut out for re- setting as protection for cooling fans. Each individual fan shall have its own thermal relay. Ambient operating temperature range: 0 to 45 deg.C maximum.

14.4.3 **Inverter:**

i. The static inverter shall be of solid state type using proven pulse width modulation (PWM) technique. The inverter equipment shall include all necessary control circuitry and devices to conform requirements like voltage regulation, current limiting, wave shaping, transient recovery, automatic synchronization etc. as given below.

ii. The inverter shall utilize IGBT which shall provide intelligent features like the drive circuitry, over-current protection, over temperature protection, control power failure protection and

short circuit protection.

iii. The IGBT / IPM transistors shall enable high speed switching of 6 Khz thus reducing the heat dissipation in the UPS and thereby providing high efficiency.

iv. The UPS shall utilize both voltage and current feedback control circuits so that the inverter shall act not only as a constant voltage source but also as a load required current source. This shall enable the inverter to quickly adapt to the changing load current value and wave shape.

v. The inverter output voltage shall not deviate by more than + 2% RMS due to the following steady state conditions:
   a. From 0 to 100% loading
   b. Inverter DC input voltage varies from maximum to minimum

vi. The inverter output frequency shall be controlled by an oscillator internal to the UPS module logic.

vii. The inverter output frequency shall not vary during steady state or transient operation due to the following conditions:
   a. From 0 to 100% loading.
   b. Inverter DC input varies from maximum to minimum.

viii. The inverter output shall limit the amount of harmonic content to the values stated in section. The use of excessive or additional filtering shall not be required to limit the harmonic content thus maintaining a high level of efficiency, reliability and original equipment footprint.

ix. The inverter output shall be capable of providing an overload current while maintaining rated output voltage to the values stated. An LED indicator shall be located on the control panel to identify this condition. If the time limit associated with the overload condition expires or the overload is in excess of the set current amplitude, the load shall be transferred to the bypass source without interruption.

x. The inverter output shall be limited to 150% of rated load current.

xi. The AC output from the inverter shall utilize fuses for overload protection. The inverter shall utilize a contactor to isolate the inverter output from the critical bus. The inverter fuses shall be the fast acting semiconductor type. The inverter output isolation contactor shall be located in the UPS module and shall be controlled by the internal UPS module system logic.

xii. The inverter shall meet the following specifications in addition to other requirements stated herein:
   a. Voltage Input: Three Phase UPS / 1 phase UPS
   b. Nominal DC (Range 300 V to 420 V DC to maximum DC bus voltage during charging the batteries).
   c. Nominal Voltage Output: 415 V + 1% AC 3 Phase, 4 Wire / 240V, 1Phase
   d. Voltage Regulation: 0 to 100% loading: <+ 1%
   e. Transient Voltage Regulation:
      - At 100% step load change: <+ 3%
      - At loss or return of AC input: <+ 1%
      - At load transfer from bypass to inverter: <+ 3%
      - Total voltage harmonic distortion :< 5% THD for 100% linear load < 7% THD for 100% non-linear load
      - Output power factor > 0.9
      - Duty: Continuous
      - Cooling: Forced cooling using fans.
      - Ambient operating temperature range: 0 to 40 deg.C maximum continuous.
      - Output: Suitable terminals are provided for termination of cables for connecting inverter output to AC distribution board.

14.4.4 **Isolation transformer and bypass switches:**

i. This shall provide neutral separation which shall mean that output neutral will be independent of incoming neutral, hence critical load shall be isolated from the problems like incoming neutral open or, short or, variations in neutral to earth voltage due to

sudden loading in neighboring installation. The isolation transformer shall be connected so as to protect any unwanted voltage fluctuations in neutral to protect the UPS

ii. In the event of Phase sequence reversal at the input, UPS system shall continue to work and shall not trip the UPS system.

iii. A bypass circuit shall be provided as an alternate source of power other than the inverter. A high speed switch and wrap-around contactor shall be used for the critical load during automatic transfers to the bypass circuit. The static switch and wrap-around contactor shall drive power from an upstream bypass feed circuit breaker internal to the UPS module provided for overload protection. The wrap-around contactor shall be electrically connected

in parallel to the static switch and shall at the same time as the static switch, energize and upon closure, maintain the bypass source. The static switch shall only be utilized for the time needed to energize the wrap-around contactor thus increasing reliability. The bypass circuit shall be capable of supplying the UPS rated load current and also provide fault clearing current.

iv. The UPS system logic shall employ sensing which shall cause the static switch to energize within 150 microseconds thus providing an uninterrupted transfer to the bypass source when any of the following limitations shall exceed:
   a. Inverter output under voltage or over voltage.
   b. Overload beyond the capability of the inverter
   c. DC circuit under voltage or over voltage
   d. Final end voltage of system battery is reached.
   e. Bypass source present and available
   f. System failure (eg. Logicfail, fuse blown, etc.)

v. Keeping the above requirements in view, the static switch shall have the following minimum rating.
   a. Capacity continuous equal to 100% of continuous rating of the inverter.
   b. Capacity overload equivalent to overload characteristics specified for UPS.
   c. Nominal bypass input voltage: 415 V, 3 phase, 4 wire/240v 1P
   d. Voltage Range: +10% of nominal
   e. Nominal Frequency: 50 Hz
   f. Frequency range: + 6%
   g. Output Fault Clearing: Current: 1000%, Duration: 20 milli seconds
   h. Duty: Continuous

vi. In the event that the critical load must be transferred to the bypass source due to an overload, the UPS system logic monitors the overload condition and, upon the overload being cleared, performs an automatic re-transfer back to the inverter output.

vii. The UPS shall be capable of transferring the critical load to / from the bypass source via LCD touch panel. When performing manual transfer to inverter or automatic re-transfers, the UPS system logic shall force the inverter output voltage to match the bypass input voltage and then parallel the inverter and bypass source providing a make-before-break transition allowing a controlled walk-in of load current to the inverter.

viii. The UPS shall include as standard equipment, a zero energy maintenance bypass switch. Full UPS wraparound enables personnel to do work inside the UPS module or maintenance bypass switchboard without danger for high voltage conditions.

ix. The UPS shall have built-in protection against: surges, sags, and over-current from the AC rectifier input source, over-voltage and voltage surges from output terminals of paralleled sources, and load switching and circuit breaker operation in the distribution system.

x. The UPS shall be protected against sudden changes in output load and short circuits at the output terminals. The UPS shall have built-in protection against permanent damage to itself and the connected load for all predictable types of malfunctions. Fast-acting current limiting devices shall be used to protect against cascading failure of solid-state devices. Internal UPS malfunctions shall cause the module to trip off-line with minimum damage to the module and provide maximum information to maintenance personnel regarding the reason for tripping off line. The load shall be automatically transferred to the bypass line uninterrupted, should the connected critical load exceed the capacity of the available on- line modules. The status of protective devices shall be indicated on a graphic display screen on the front of the unit.

14.4.5 **Battery system:**

i. The battery system shall be sized to provide 30 minutes' backup time when the UPS is supplying100% rated load at 0.9 load power factor.

ii. The battery system design shall be provided with necessary devices to prevent deep discharge beyond recommended limits to prevent the batteries discharging beyond end cell voltage specified by the battery maker. The connections from battery to battery shall be by using copper cable and BCB (Battery circuit breaker).

iii. All batteries shall be clearly identified and identification numbers marked on the batteries and a schematic diagram along with the complete calculations, including manufacturers supporting curves, shall be submitted with the tender.

iv. Batteries shall be VRLA (Maintenance-Free) type. Constant current boost charging, constant voltage boost charging, float charging (float charging compensation) and EOD protection are available for different kinds of batteries.

v. Charging: In addition to supplying power to the load, the battery converter shall be capable of producing a battery charging current sufficient to replace 95% of the battery discharge power within ten (10) times the discharge time. Ripple voltage at the battery terminal

(RMS) should be less than 1%, and ripple current must not exceed 5% (of C-10 Ah rating) nominal discharging current. (Number of battery is 25 - 40 blocks; nominal voltage is 12V per block).

vi. Discharging: The battery converter will supply power to the inverter when the rectifier is shut down or in joint mode, and also the rectifier is current limiting.

14.4.6 **Operation:**

i. Under normal operation, the UPS load will be fed from the Inverter with the bypass switch inhibited. The rectifier, apart from providing DC power to the Inverter, also charges the battery under the float charge mode. The battery charge system shall have float charge, equalizing charge and recovery charge modes, to replenish the batteries self-discharging part while the battery is fully charged, equalizing the battery cell voltage to a constant value forcibly, and recharging the battery system to the required values when the batteries have been used, respectively.

ii. The Inverter shall constantly monitor the AC source frequency and shall be in synchronization with the AC input source till the frequency of the AC input source is within synchronizing limit and if the frequency of the standby source exceeds the synchronizing limit the Inverter will work on its own internal oscillator maintaining an output frequency of 50 Hz +/- 0.01% under all conditions of load. When the Inverter operates on its internal oscillator, it shall continuously monitor the frequency of the input source and when the input source frequency returns to within synchronization limit, the Inverter shall automatically synchronize itself with the input A/C source frequency and use it as a signal for Inverter output frequency control.

iii. When the A/C input voltage drops below specified limits or in case of a power failure the Inverter continues to supply AC power of constant voltage and constant frequency utilizing the battery system as a power source until the input voltage returns to normal requirement. When the power supply is resumed or the input voltage returns to limits, the Converter shall automatically start and the load fed for normal operation status.

iv. If the power failure continues beyond battery backup time or the battery voltage drops to the final discharge voltage, the Inverter should automatically stop and at the same time transferring the load to the bypass circuit. On resumption of power supply, the Converter shall automatically re-start the operations and charge the batteries whereas the Inverter should inhibit automatic start and should be started manually.

v. When power is supplied from the Inverter in synchronization with the bypass, it shall accomplish the following:

   a. When the UPS output current reaches overload status it shall automatically transfer the load to bypass circuit with no interruption and when the overload status is cleared it automatically re-transfers the load to Inverter.
   b. When the battery final discharge condition is reached, the load shall automatically be transferred to the bypass circuit without interruption.
   c. In case of failure of the UPS, the load shall be automatically transferred to the bypass circuit with no interruption and when the failure is cleared, re-transfer the load to the Inverter shall be done manually.
   d. There should be provision made in the system to prevent, when necessary, asynchronous transfer.
   e. When the UPS goes on bypass mode in any of the conditions described above and if at that time there is no bypass power supply available due to power failure, the UPS shall remain in standby mode and as soon as the bypass power supply is available will transfer the load to bypass.
   f. A maintenance bypass transfer switch shall be provided with lock and key arrangement and should be manually done by authorized personnel only.

vi. The entire UPS system, including all components like inverter, static switch, maintenance bypass, shall be housed in free-standing steel type factory-finished enclosures complying with the protection standards of IP20. The enclosure shall be open able using a special tool for internal access. The color shall be light grey.

vii. Forced air-cooling shall be provided to allow components to operate within their rated temperature specified. The cooling fans shall have thermal relays protection using a latched cut fire re-setting, as a protection for the cooling fans.

14.4.7 **Control and monitoring:**

i. The UPS shall have Simple Network Management Protocol (SNMP) card with system (RS485 compatibility port) for interfacing to IBMS system in future or client's centralized computer network for Control and Monitoring System.

ii. It shall be provided with LED displays. The display system shall have, as minimum individual

iii. LEDs with different colors for the following:

a. Load on Inverter
b. Battery operation
c. Load on Bypass
d. A.UPS failure
e. LCD failure
f. Overload

iv. Statistical data providing all statistical data like no. of days of UPS operation, no. of mains failures up to 1min, 2min etc., no. of overloads up to 110%, 125% etc, no. of hours' operation on battery & on bypass etc., no. of hours' battery temp exceeded 25-degree C.

v. LCD touch panel

vi. The UPS shall be provided with an operator friendly large scale LCD touch panel.

vii. The LCD touch panel shall also include graphic measurement display, operational procedures of each activity, fault status display and also have capability to record at least 50 faults.

viii. The touch screen panel shall clearly define specified areas for operational function, execution and message display.

ix. It should be possible to operate the entire UPS system and its components and obtain all measurements and data through the touch screen operation. The measurement software should provide capability to measure phase voltage, current in each phase, frequency, power factor, available battery time etc.

x. Under all operating conditions, the system software should have capability for displaying fault alarm automatically. The Firm should describe in detail the faults that would be displayed under this mode.

14.5 INSTALLATION, TESTING & COMMISSIONING:

i. Installation of UPS shall be carried out as per manufacturer's instructions and installation shall be verified by the manufacturer before energizing.

ii. Type testing shall be conducted from accredited Lab. Copies of the test certificates for same rating shall be submitted at the time of vendor approval. These shall not be more than 5 years old from the date of approval of drawing.

iii. Testing at manufacturers' works shall be conducted before dispatch as per routine verification requirements.

iv. Physical check including checking damage/crack in any components, etc shall be done at site.

v. Following test shall be performed, as a minimum, at site prior to handing over, to confirm the functional and the performance specification of the UPS as specified. All required test equipment like Digital Oscilloscope, Voltage Regulator and Measurement Meters etc. shall be the responsibility of the concerning vendor without any additional cost.

vi. Full load testing of UPS with required size load bank shall be done at site as per the approved QAP. All testing expenses including load bank and its arrangements shall be under the scope of vendor.

vii. The vendor shall demonstrate as a minimum the following features on site by providing all required test equipment, such as power factor improvement, input current THD, output voltage THD, output frequency and all other performance monitoring requirements detailed before as required by the Owner.

15. FIRE ALARM SYSTEM:

15.1 GENERAL:

All equipment and components shall be new, and the manufacturer's current model. The materials, appliances, equipment and devices shall be tested and listed by a nationally recognized approvals agency for use as part of a protective signaling system, meeting the National Fire Alarm Code.

All equipment and components shall be installed in strict compliance with manufacturers' recommendations. Consult the manufacturer's installation manuals for all wiring diagrams, schematics, physical equipment sizes, etc., before beginning system installation.

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

15.2 SPECIFICATIONS:

15.2.1 **Conduit:**

Conduit shall be in accordance with The National Electrical Code (NEC), local and state requirements. Where required, all wiring shall be installed in conduit or raceway. Conduit fill shall not exceed 40 percent of interior cross sectional area where three or more cables are contained within a single conduit.

Cable must be separated from any open conductors of power, or Class 1 circuits, and shall not be placed in any conduit, junction box or raceway containing these conductors, per NEC Article 760-29.

Wiring for 24 volt DC control, alarm notification, emergency communication and similar power-limited auxiliary functions may be run in the same conduit as initiating and signaling line circuits. All circuits shall be provided with transient suppression devices and the system shall be designed to permit simultaneous operation of all circuits without interference or loss of signals.

Conduit shall not enter the fire alarm control panel, or any other remotely mounted control panel equipment or backboxes, except where conduit entry is specified by the FACP manufacturer.

Conduit shall be 3/4-inch (19.1 mm) minimum.

15.2.2 **Wire:**

All fire alarm system wiring shall be new. Wiring shall be in accordance with local, state and national codes (e.g., NEC Article 760) and as recommended by the manufacturer of the fire alarm system. Number and size of conductors shall be as recommended by the fire alarm system manufacturer, but not less than 18 AWG (1.02 mm) for Initiating Device Circuits and Signaling Line Circuits, and 14 AWG (1.63 mm) for Notification Appliance Circuits.

All wire and cable shall be listed and/or approved by a recognized testing agency for use with a protective signaling system.

15.2.3 **Main Fire Alarm Control Panel or Network Node:**

The main FACP Central Console shall contain a microprocessor based Central Processing Unit (CPU). The CPU shall communicate with and control the following types of equipment used to make up the system: intelligent addressable smoke and thermal (heat) detectors, addressable modules, panel modules including initiating circuits, control circuits, and notification appliance circuits, local and remote operator terminals, printers, annunciators, and other system-controlled devices.

In conjunction with intelligent Loop Control Modules and Loop Expander Modules, the

main FACP shall perform the following functions:

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

Supervise all initiating signaling and notification circuits throughout the facility by way of connection to monitor and control modules.

Detect the activation of any initiating device and the location of the alarm condition. Operate all notification appliances and auxiliary devices as programmed. In the event of CPU failure, all SLC loop modules shall fall back to degrade mode. Such degrade mode shall treat the corresponding SLC loop control modules and associated detection devices as conventional two-wire operation. Any activation of a detector in this mode shall automatically activate associated Notification Appliance Circuits.

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

When a fire alarm condition is detected and reported by one of the system initiating devices or appliances, the following functions shall immediately occur:

The system alarm LED shall flash.

A local piezo-electric audible device in the control panel shall sound a distinctive signal.

The 640-character backlit LCD/ 6 “ (Six inch) LCD display shall indicate all information associated with the fire alarm condition, including the type of alarm point and its location within the protected premises.

Printing and history storage equipment shall log and print the event information along with a time and date stamp.

All system outputs assigned via preprogrammed equations for a particular point in alarm shall be executed, and the associated system outputs (alarm notification appliances and/or relays) shall be activated.

When a trouble condition is detected and reported by one of the system initiating devices or appliances, the following functions shall immediately occur:

a. The system trouble LED shall flash.
b. A local piezo-electric audible device in the control panel shall sound a distinctive signal.
c. The 640-character backlit LCD display / 6 “(Six inch) LCD display shall indicate all information associated with the trouble condition, including the type of trouble point and its location within the protected premises.
d. Printing and history storage equipment shall log and print the event information along with a time and date stamp.
e. All system outputs assigned via preprogrammed equations for a particular point in trouble shall be executed, and the associated system outputs (trouble notification appliances and/or relays) shall be activated.

When a supervisory condition is detected and reported by one of the system initiating devices or appliances, the following functions shall immediately occur:

a. The system trouble LED shall flash.
b. A local piezo-electric audible device in the control panel shall sound a distinctive signal.
c. The 640-character backlit LCD display / 6 “ (Six inch) LCD displayshall indicate all information associated with the supervisory condition, including the type of trouble point and its location within the protected premises.
d. Printing and history storage equipment shall log and print the event information along with a time and date stamp.
e. All system outputs assigned via preprogrammed equations for a particular point in trouble shall be executed, and the associated system outputs (notification appliances and/or relays) shall be activated.

When a security alarm condition is detected and reported by one of the system initiating devices or appliances, the following functions shall immediately occur:

a. The system security LED shall flash.

b. A local piezo-electric audible device in the control panel shall sound a distinctive signal.
c. The 640-character backlit LCD display / 6 " (Six inch) LCD displayshall indicate all information associated with the fire alarm condition, including the type of alarm point and its location within the protected premises.
d. Printing and history storage equipment shall log and print the event information along with a time and date stamp.
e. All system outputs assigned via preprogrammed equations for a particular point in alarm shall be executed, and the associated system outputs (alarm notification appliances and/or relays) shall be activated.

When a pre-alarm condition is detected and reported by one of the system initiating devices or appliances, the following functions shall immediately occur:

a. The system pre-alarm LED shall flash.
b. A local piezo-electric audible device in the control panel shall sound a distinctive signal.
c. The 640-character backlit LCD display / 6 " (Six inch) LCD displayshall indicate all information associated with the fire alarm condition, including the type of alarm point and its location within the protected premises.
d. Printing and history storage equipment shall log and print the event information along with a time and date stamp.
b. All system outputs assigned via preprogrammed equations for a particular point in alarm shall be executed, and the associated system outputs (alarm notification appliances and/or relays) shall be activated.

15.2.3.1 **Operator Control:**

i. Acknowledge Switch:

Activation of the control panel acknowledge switch in response to new alarms and/or troubles shall silence the local panel piezo electric signal and change the alarm and trouble LEDs from flashing mode to steady-ON mode. If multiple alarm or trouble conditions exist, depression of this switch shall advance the LCD display to the next alarm or trouble condition. In addition, the FACP shall support Block Acknowledge to allow multiple trouble conditions to be acknowledged with a single depression of this switch.

Depression of the Acknowledge switch shall also silence all remote annunciator piezo sounders.

ii. Signal Silence Switch:

Depression of the Signal Silence switch shall cause all programmed alarm notification appliances and relays to return to the normal condition. The selection of notification circuits and relays that are silence able by this switch shall be fully field programmable within the confines of all applicable standards. The FACP software shall include silence inhibit and auto-silence timers.

iii. System Reset Switch:

Depression of the System Reset switch shall cause all electronically latched initiating devices to return to their normal condition. Initiating devices shall re-report if active. Active notification appliance circuits shall not silence upon Reset. Systems that de-activate and subsequently re-activate notification appliance circuits shall not be considered equal. All programmed Control-By-Event equations shall be re-evaluated after the reset sequence is complete if the initiating condition has cleared. Non-latching trouble conditions shall not clear and re-report upon reset.

iv. Lamp Test:

The Lamp Test switch shall activate all local system LEDs, light each segment of the liquid crystal display and display the panel software revision for service personal.

v. Scroll Display Keys:
There shall be Scroll Display keys for FIRE ALARM, SECURITY, SUPERVISORY, TROUBLE, and OTHER EVENTS. Depression of the Scroll Display key shall display the next event in the selected queue allowing the operator to view events by type.

vi. Print Screen:
Depression of the PRINT SCREEN switch shall send the information currently displayed on the 640-character display / 6“(Six inch) LCD display to the printer.

15.2.3.2 **System Capacity and General Operation:**

The control panel shall be capable of expansion via up to 10 SLC modules. Each module shall support a maximum of 250 analog/addressable devices for a maximum system capacity of 2500 points in any combination.

The Fire Alarm Control Panel shall include a full featured operator interface control and annunciation panel that shall include a backlit 6 inch or 640-character liquid crystal display, individual, color coded system status LEDs, and a QWERTY style alphanumeric keypad for the field programming and control of the fire alarm system.
Said LCD shall also support

graphic bit maps capable of displaying the company name and logo of either the owner or installing company.

All programming or editing of the existing program in the system shall be achieved without special equipment and without interrupting the alarm monitoring functions of the fire alarm control panel.

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

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

ii. Smoke Detector Pre-alarm Indication at Control Panel: To obtain early warning of incipient or potential fire conditions, the system shall support a programmable option to determine system response to real-time detector sensing values above the programmed setting. Two levels of Pre-alarm indication shall be available at the control panel: alert and action.
iii. Alert: It shall be possible to set individual smoke detectors for pre-programmed pre-alarm thresholds. If the individual threshold is reached, the pre-alarm condition shall be activated.
iv. Action: If programmed for action, and the detector reaches a level exceeding the pre-programmed level, the control panel shall indicate an action condition. Sounders installed will automatically activate with general evacuation on alarm level.
v. The system shall support a detector response time to meet world annunciation requirements of less than 3 seconds.
vi. Device Blink Control: Means shall be provided to turn off detector/module LED strobes for special areas.
vii. NFPA 72 Smoke Detector Sensitivity Test: The system shall provide an automatic smoke detector test function that meet the requirements of NFPA 72.
viii. Programmable Trouble Reminder: The system shall provide means to automatically initiate a reminder that troubles exist in the system. The reminder will appear on the system display and (if enabled) will sound a piezo alarm.
ix. On-line or Off-line programming: The system shall provide means to allow panel programming either through an off-line software utility program away from the panel or while connected and on-line. The system shall also support upload and download of programmed database and panel executive system program to a Personal Computer/laptop.

x. History Events: The panel shall maintain a history file of the last minimum 5000 events, each with a time and date stamp. History events shall include all alarms, troubles, operator actions, and programming entries.
xi. Smoke Control Modes: The system shall provide means to perform FSCS mode Smoke Control to meet NFPA-92A and 90B and HVAC mode to meet NFPA 90A.
xii. The system shall provide means for all SLC devices on any SLC loop to be auto programmed into the system by specific address. The system shall recognize specific device type ID's and associate that ID with the corresponding address of the device.
xiii. Drill: The system shall support means to activate all silenceable fire output circuits in the event of a practice evacuation or "drill". If enabled for local control, the front panel switch shall be held for a minimum of 2 seconds prior to activating the drill function
xiv. Passwords and Users: The system shall support two password levels, master and user. Up to 9 user passwords shall be available, each of which may be assigned access to the programming change menus, the alter status menus, or both. Only the master password shall allow access to password change screens.
xv. Block Acknowledge: The system shall support a block Acknowledge for Trouble Conditions
xvi. Sensitivity Adjust: The system shall provide Automatic Detector Sensitivity Adjust based on Occupancy schedules including a Holiday list of up to 15 days.
xvii. Environmental Drift Control: The system shall provide means for setting Environmental Drift Compensation by device. When a detector accumulates dust in the chamber and reaches an unacceptable level but yet still below the allowed limit, the control panel shall indicate a maintenance alert warning. When the detector accumulates dust in the chamber above the allowed limit, the control panel shall indicate a maintenance urgent warning.
xviii. Custom Action Messages: The system shall provide means to enter up to 100 custom action messages of up to 160 characters each. It shall be possible to assign any of the 100 messages to any point.
xix. Print Functions: The system shall provide means to obtain a variety of reports listing all event, alarm, trouble, supervisory, or security history. Additional reports shall be available

for point activation for the last Walk Test performed, detector maintenance report containing the detector maintenance status of each installed addressable detector, all network parameters, all panel settings including broad cast time, event ordering, and block acknowledge, panel timer values for Auto Silence, Silence Inhibit, AC Fail Delay time and if enabled, Proprietary Reminder, and Remote Reminder timers, supervision settings for power supply and printers, all programmed logic equations, all custom action messages, all non-fire and output activations (if pre-programmed for logging) all active points filtered by alarms only, troubles only, supervisory alarms, prealarms, disabled points and activated points, all installed points filtered by SLC points, panel circuits, logic zones, annunicators, releasing zones, spal zones, and trouble zones.

xx. Local Mode: If communication is lost to the central processor the system shall provide added survivability through the intelligent loop control modules. Inputs from devices connected to the SLC and loop control modules shall activate outputs on the same loop when the inputs and outputs have been set with point programming to participate in local mode or when the type codes are of the same type: that is, an input with a fir alarm type code shall activate an output with a fire alarm type code.
xxi. Resound based on type for security or supervisory: The system shall indicate a Security alarm when a monitor module point programmed with a security Type Code activates. If silenced alarms exist, a Security alarm will resound the panel sounder. The system shall indicate a Supervisory alarm when a monitor module point programmed with a supervisory Type Code activates. If there are silenced alarms, a Supervisory alarm will resound the panel sounder.
xxii. Read status preview - enabled and disabled points: Prior to re-enabling points, the system shall inform the user that a disabled device is in the alarm state. This shall provide notice that the device must be reset before the device is enabled thereby avoiding activation of the notification circuits.
xxiii. Custom Graphics: When fitted with an LCD display, the panel shall permit uploading of a custom bit-mapped graphic to the display screen. Graphic shall display when all systems are normal.
xxiv. Multi-Detector and Cooperating Detectors: The system shall provide means to link one detector to up to two detectors at other addresses on the same loop in cooperative multi- detector sensing. There shall be no requirement for sequential addresses on the detectors and the alarm event shall be a result or product of all cooperating detectors chamber readings.
xxv. Tracking/Latching Duct: The system shall support both tracking and latching duct

detectors.

xxvi. ACTIVE EVENT: The system shall provide a Type ID called FIRE CONTROL for purposes of air-handling shutdown, which shall be intended to override normal operating automatic functions. Activation of a FIRE CONTROL point shall cause the control panel to (1) initiate the monitor module Control-by-Event, (2) send a message to the panel display, history buffer, installed printer and annunciators, (3) shall not light an indicator at the control panel,

(4) Shall display ACTIVE on the LCD as well a display a FIRE CONTROL Type Code and other information specific to the device.

xxvii. NON-FIRE Alarm Module Reporting: A point with a type ID of NON-FIRE shall be available for use for energy management or other non-fire situations. NON-FIRE point operation shall not affect control panel operation nor shall it display a message at the panel LDC. Activation of a NON-FIRE point shall activate control by event logic but shall not cause any indication on the control panel.

xxviii. Security Monitor Points: The system shall provide means to monitor any point as a type security.

xxix. One-Man Walk Test: The system shall provide both a basic and advanced walk test for testing the entire fire alarm system. The basic walk test shall allow a single operator to run audible tests on the panel. All logic equation automation shall be suspended during the test and while annunciators can be enabled for the test, all shall default to the disabled state. During an advanced walk test, field-supplied output point programming will react to input stimuli such as CBE and logic equations. When points are activated in advanced test mode, each initiating event shall latch the input. The advanced test shall be audible and shall be used for pull station verification, magnet activated tests on input devices, input and output device and wiring operation/verification.

xxx. Control by Event Functions: CBE software functions shall provide means to program a variety of output responses based on various initiating events. The control panel shall operate CBE through lists of zones. A zone shall become listed when it is added to a point's zone map through point programming. Each input point such as detector, monitor module or panel circuit module shall support listing of up to 10 zones into its programmed zone map.

xxxi. Permitted zone types shall be general zone, releasing zone and special zone. Each output point (control module, panel circuit module) can support a list of up to 10 zones including

general zone, logic zone, releasing zone and trouble zone. It shall be possible for output points to be assigned to list general alarm. Non-Alarm or Supervisory points shall not activate the general alarm zone.

xxxii. 1000 General Zones: The system shall support up to 1000 general purpose software zones for linking inputs to outputs. When an input device activates, any general zone programmed into that device's zone map will be active and any output device that has an active general zone in its map will be active. It shall also be possible to use general zone as arguments in logic equations.

xxxiii. 1000 Logic Equations: The system shall support up to 1000 logic equations for AND, OR, NOT, ONLY1, ANYX, XZONE or RANGE operators that allow conditional I/O linking. When any logic equation becomes true, all output points mapped to the logic zone shall activate.

xxxiv. 10 trouble equations per device: The system shall provide support for up to 10 trouble equations for each device, which shall permit programming parameters to be altered, based on specific fault conditions. If the trouble equation becomes true, all output points mapped to the trouble zone shall activate.

xxxv. Control-By-Time: A time based logic function shall be available to delay an action for a specific period of time based upon a logic input with tracking feature. A latched version shall also be available. Another version of this shall permit activation on specific days of the week or year with ability to set and restore based on a 24-hour time schedule on any day of the week or year.

xxxvi. Multiple agent releasing zones: The system shall support up to 10 releasing zones to protect against 10 independent hazards. Releasing zones shall provide up to three cross- zone with four abort options to satisfy any local jurisdiction requirements.

xxxvii. Alarm Verification, by device, with timer and tally: The system shall provide a user-defined global software timer function that can be set for a specific detector or indicating panel module input. The timer function shall delay an alarm signal for a user-specified time period and the control panel shall ignore the alarm verification timer if another alarm is detected during the verification period. It shall also be possible to set a maximum verification count between 0 and 20 with the "0" setting producing no alarm verification. When the counter exceeds the threshold value entered, a trouble shall be

generated to the panel.

15.2.4 **Central Processing Unit**

i. The Central Processing Unit shall communicate with, monitor, and control all other modules within the control panel. Removal, disconnection or failure of any control panel module shall be detected and reported to the system display by the Central Processing Unit.

ii. The Central Processing Unit shall contain and execute all control-by-event (including Boolean functions including but not limited to AND, OR, NOT, ANYx, and CROSSZONE) programs for specific action to be taken if an alarm condition is detected by the system. Such control-by-event programs shall be held in non-volatile programmable memory, and shall not be lost with system primary and secondary power failure.

iii. The Central Processing Unit shall also provide a real-time clock for time annotation, to the second, of all system events. The time-of-day and date shall not be lost if system primary and secondary power supplies fail.

iv. The CPU shall be capable of being programmed on site without requiring the use of any external programming equipment. Systems that require the use of external programmers or change of EPROMs are not acceptable.

v. Consistent with UL864 standards, the CPU and associated equipment are to be protected so that voltage surges or line transients will not affect them.

vi. Each peripheral device connected to the CPU shall be continuously scanned for proper operation. Data transmissions between the CPU and peripheral devices shall be reliable and error free. The transmission scheme used shall employ dual transmission or other equivalent error checking techniques.

vii. The CPU shall provide an EIA-232 interface between the fire alarm control panel and the UL Listed Electronic Data Processing (EDP) peripherals.

viii. The CPU shall provide two EIA-485 ports for the serial connection to annunciation and control subsystem components.

ix. The EIA-232 serial output circuit shall be optically isolated to assure protection from earth ground.

x. The CPU shall provide one high-speed serial connection for support of network communication modules.

xi. The CPU shall provide double pole relays for FIRE ALARM, SYSTEM TROUBLE, SUPERVISORY, and SECURITY. The SUPERVISORY and SECURITY relays shall provide selection for additional FIRE ALARM contacts.

15.2.5 **Display**

i. The system display shall provide all the controls and indicators used by the system operator and may also be used to program all system operational parameters.

ii. The display assembly shall contain, and display as required, custom alphanumeric labels for all intelligent detectors, addressable modules, and software zones.

iii. The system display shall provide a 6 inch or 640-character backlit alphanumeric Liquid Crystal Display (LCD). It shall also provide ten Light-Emitting-Diodes (LEDs), that indicate the status of the following system parameters: AC POWER, FIRE ALARM, PREALARM, SECURITY, SUPERVISORY, SYSTEM TROUBLE, OTHER EVENT, SIGNALS SILENCED, POINT DISABLED, and CPU FAILURE.

iv. The system display shall provide a QWERTY style keypad with control capability to command all system functions, entry of any alphabetic or numeric information, and field programming. Two different password levels with up to ten (one Master and nine User) passwords shall be accessible through the display interface assembly to prevent unauthorized system control or programming.

v. The system display shall include the following operator control switches: ACKNOWLEDGE, SIGNAL SILENCE, RESET, DRILL, and LAMP TEST. Additionally, the display interface shall allow scrolling of events by event type including, FIRE ALARM, SECURITY, SUPERVISORY, TROUBLE, and OTHER EVENTS. A PRINT SCREEN button shall be provided for printing the event currently displayed on the 640-character LCD / 6 “ (Six inch) LCD display.

15.2.6 **Loop Card:**

i. The Loop Card shall monitor and control a minimum of 250 intelligent addressable devices and additional capacity for Loop Cable Isolators. This includes detectors, monitor or control modules in any combination.

ii. The Loop Card shall contain its own microprocessor and shall be capable of operating in a local/degrade mode (any addressable device input shall be capable of activating

any or all addressable device outputs) in the unlikely event of a failure in the main CPU.

iii. The Loop Card shall provide power and communicate with all intelligent addressable detectors and modules on a single pair of wires. This Loop shall be capable of operating as a NFPA Style 6 (Class B) circuit.

iv. The Loop interface board shall be able to drive an NFPA Style 6 twisted shielded circuit up to 4500 feet in length. The loop Interface shall also be capable of driving an NFPA Style 6, no twist, no shield circuit up to 3,000 feet in length. In addition, loop wiring shall meet the listing requirements for it to exit the building or structure. "T"-tapping shall be allowed in either case.

v. The Loop interface board shall receive analog or digital information from all intelligent detectors and shall process this information to determine whether normal, alarm, or trouble conditions exist for that particular device. Each Loop shall be isolated and equipped to annunciate an Earth Fault condition. The interface board software shall include software to automatically maintain the detector's desired sensitivity level by adjusting for the effects of environmental factors, including the accumulation of dust in each detector. The analog information may also be used for automatic detector testing and the automatic determination of detector maintenance requirements.

15.2.7 **Enclosures:**

i. The control panel shall be housed in a UL-listed cabinet suitable for surface or semi-flush mounting. The cabinet and front shall be corrosion protected, given a rust-resistant prime coat, and manufacturer's standard finish.

ii. The back box and door shall be constructed of 0.060 steel with provisions for electrical conduit connections into the sides and top.

iii. The door shall provide a key lock and shall include a glass or other transparent opening for viewing of all indicators. For convenience, the door may be site configured for either right or left hand hinging.

iv. The control unit shall be modular in structure for ease of installation, maintenance, and future expansion.

15.2.8 **Power Supply:**

i. The Addressable Main Power Supply shall operate on 120/240 VAC, 50/60 Hz, and shall provide all necessary power for the FACP.

ii. The Addressable Main Power Supply shall provide sufficient power to the CPU, using a switching 24 VDC regulator and shall incorporate a battery charger for 24 hours of standby power using dual-rate charging techniques for fast battery recharge.

iii. The Addressable Main Power Supply shall provide a battery charger for 24 hours of standby using dual-rate charging techniques for fast battery recharge. The supply shall be capable of charging batteries ranging in capacity from 25-200 amp-hours within a 48-hour

period.

iv. The Addressable Main Power Supply shall provide a very low frequency sweep earth detect circuit, capable of detecting earth faults.

v. The Addressable Main Power Supply shall be power-limited per 1995 UL864 requirements.

15.2.9 **Controls with associated LED Indicators:**

i. Speaker Switches/Indicators

a. The speaker circuit control switches/indicators shall include visual indication of active and trouble status for each speaker circuit in the system.

b. The speaker circuit control panel shall include switches to manually activate or deactivate each speaker circuit in the system.

ii. Emergency Two-Way Telephone Control Switches/Indicators

a. The emergency telephone circuit control panel shall include visual indication of active and trouble status for each telephone circuit in the system.

b. The telephone circuit control panel shall include switches to manually activate or deactivate each telephone circuit in the system.

15.2.10 **Remote Transmissions:**

i. Provide local energy or polarity reversal or trip circuits as required.

ii. The system shall be capable of operating a polarity reversal or local energy or fire alarm transmitter for automatically transmitting fire information to the fire department.

iii. Provide capability and equipment for transmission of zone alarm and trouble signals to remote operator's terminals, system printers and annunciators.

iv. Transmitters shall be compatible with the systems and equipment they are connected

to such as timing, operation and other required features.

15.2.11 **Auxiliary Addressable Power Supply**

i. The auxiliary addressable power supply is a remote 24 VDC power supply used to power Notification Devices and field devices that require regulated 24VDC power. The power supply shall also include and charge backup batteries.

ii. The addressable power supply for the fire alarm system shall provide up a minimum of 6.0 amps of 24 volt DC regulated power for Notification Appliance Circuit (NAC) power or 5 amps of 24 volt DC general power. The power supply shall have an additional .5 amp of 24 VDC auxiliary power for use within the same cabinet as the power supply. It shall include an integral charger designed to charge 7.0 - 25.0 amp hour batteries.

iii. The addressable power supply shall provide four individually addressable Notification Appliance Circuits that may be configured as two Class "A" and two Class "B" or four Class "B" only circuits. All circuits shall be power-limited per UL 864 requirements.

iv. The addressable power supply shall provide built-in synchronization for certain Notification Appliances on each circuit without the need for additional synchronization modules. The power supply's output circuits shall be individually selected for synchronization. A single addressable power supply shall be capable of supporting both synchronized and non- synchronized Notification Devices at the same time.

v. The addressable power supply shall operate on 120 or 240 VAC, 50/60 Hz.

vi. The interface to the power supply from the Fire Alarm Control Panel (FACP) shall be via the Signaling Line Circuit (SLC) or other multiplexed means. Power supplies that do not use an intelligent interface are not suitable substitutes. The required wiring from the FACP to the addressable power supply shall be a single unshielded twisted pair wire.

vii. The addressable power supply shall supervise for battery charging failure, AC power loss, power brownout, battery failure, NAC loss, and optional ground fault detection. In the event of a trouble condition, the addressable power supply shall report the incident and the applicable address to the FACP via the SLC.

viii. The addressable power supply shall have an AC Power Loss Delay option. If this option is utilized and the addressable power supply experiences an AC power loss, reporting of the incident to the FACP will be delayed. A delay time of eight or sixteen hours shall be Dip- switch selected.

ix. The addressable power supply shall have an option for Canadian Trouble Reporting and this option shall be Dip-switch selectable.

x. The addressable power supply mounts in either the FACP backbox or it's own dedicated surface mounted backbox with cover.

xi. Each of the power supply's four output circuits shall be DIP-switch selected for Notification Appliance Circuit or General Purpose 24 VDC power. Any output circuit shall be able to provide up to 2.5 amps of 24 VDC power.

xii. The addressable power supply's output circuits shall be individually supervised when they are selected to be either a Notification Appliance Circuit when wired Class "A" or by the use of and end-of-line resistor. When the power supply's output circuit is selected as

General 24VDC power, the circuit shall be individually supervised when an end-of-line relay is used.

xiii. When selected for Notification Appliance Circuits, the output circuits shall be individually DIP-switch selectable for Steady, March Time, Dual Stage or Temporal.

xiv. When selected as a Notification Appliance Circuit, the output circuits of the addressable power supply shall have the option to be coded by the use of a universal zone coder.

xv. The addressable power supply shall interface and synchronize with other power supplies of the same type. The required wiring to interface multiple addressable power supplies shall be a single unshielded, twisted pair wire.

xvi. An individual or multiple interfaced addressable power supplies shall have the option to use an external charger for battery charging. Interfaced power supplies shall have the option to share backup battery power.

15.2.12 **Field Charging Power Supply:**

i. The FCPS is a device designed for use as either a remote 24 volt power supply or to power Notification Appliances and provide synchronization signals to visual strobe devices.

ii. The FCPS shall be available in two models offering either up to 6.0 amps (4.0 amps continuous) or 9.0 amps (6.0 amps continuous) of regulated 24-volt power. It shall include an integral charger designed to charge 7.0 amp hour batteries and to support 60-hour standby.

iii. The Field Charging Power Supply shall have two input triggers. The input trigger shall

be a Notification Appliance Circuit (from the fire alarm control panel) or a relay. Four outputs (two Style Y or Z and two style Y) shall be available for connection to the Notification devices.

iv. The FCPS shall include an attractive surface mount backbox.
v. The Field Charging Power Supply shall include the ability to delay the AC fail delay per NFPA requirements.
vi. The FCPS include power limited circuitry, per 1995 UL standards.

15.2.13 **System Circuit Supervision:**

i. The FACP shall supervise all circuits to intelligent devices, annunciators and conventional peripherals and annunciate loss of communications with these devices. The CPU shall continuously scan above devices for proper system operation and upon loss of response from a device shall sound an audible trouble, indicate that device or devices are not responding and print the information in the history buffer and on a printer.
ii. Sprinkler system valves, standpipe control valves, PIV and main gate valves shall be supervised for off-normal position.

15.2.14 **Field Wiring Terminal Blocks:**

All wiring terminal blocks shall be the plug-in/removable type and shall be capable of terminating up to 12 AWG wire. Terminal blocks that are permanently fixed to the PC board are not acceptable.

15.2.15 **Field Programming**

i. The system shall be programmable, configurable and expandable in the field with laptop computers, or other electronic interface equipment. There shall be no firmware changes required to field modify the system time, point information, equations, or annunciator programming/information.
ii. It shall be possible to program through the standard software by using laptop or FACP keyboard all system functions.
iii. All field defined programs shall be stored in non-volatile memory.
iv. Two levels of password protection shall be provided in addition to a key-lock cabinet. One level shall be used for status level changes such as point/zone disable or manual on/off commands (Building Manager). A second (higher-level) shall be used for actual change of the life safety program (installer). These passwords shall be five (5) digits at a minimum. Upon entry of an invalid password for the third time within a one minute time period an encrypted number shall be displayed. This number can be used as a reference for determining a forgotten password.
v. The installer's field programming and hardware shall be functionally tested on a computer against known parameters/norms which are established by the FACP manufacturer. A software program shall test Input-to-Output correlations, device Type ID associations, point associations, time equations, etc. This test shall be performed on an compatible PC with a verification software package. A report shall be generated of the test results and two copies turned in to the engineer(s) on record.
vi. It shall be the responsibility of the equipment supplier /installer to ensure that all equipment supplied will fit in locations designated on plans and in the specifications.

15.2.16 **Specific System Operations**

i. Smoke Detector Sensitivity Adjust: Means shall be provided for adjusting the sensitivity of any or all analog intelligent smoke detectors in the system from the system keypad or from the keyboard of the video terminal. Sensitivity range shall be within the allowed UL window.
ii. Alarm Verification: Each of the Intelligent Addressable Smoke Detectors in the system may be independently selected and enabled to be an alarm verified detector. The alarm verification function shall be programmable from 5 to 50 seconds and each detector shall be able to be selected for verification during the field programming of the system or anytime after system turn-on. Alarm verification shall not require any additional hardware to be added to the control panel. The FACP shall keep a count of the number of times that each detector has entered the verification cycle. These counters may be displayed and reset by the proper operator commands.

iii. System Point Operations:
   a. Any addressable device shall have the capability to be enabled or disabled through the system keypad or Display touch screen.

b. System output points shall be capable of being turned on or off from the system keypad or Display touch screen.

iv. Point Read:

The system shall be able to display the following point status diagnostic functions without the need for peripheral equipment. Each point shall be annunciated for the parameters listed:

a. Device Status.
b. Device Type.
c. Custom Device Label.
d. Software Zone Label.
e. Device Zone Assignments.
f. All Program Parameters.

v. System Status Reports: Upon command from an operator of the system, a status report will be generated and printed, listing all system statuses.

vi. System History Recording and Reporting: The fire alarm control panel shall contain a history buffer that will be capable of storing up to 4000 system events. Each of these events will be stored, with time and date stamp, until an operator requests that the contents be either displayed or printed. The contents of the history buffer may be manually reviewed, one event at a time, and the actual number of activations may also be displayed and or printed. The history buffer shall use non-volatile memory.

vii. Automatic Detector Maintenance Alert: The fire alarm control panel shall automatically interrogate each intelligent system detector and shall analyze the detector responses over a period of time. If any intelligent detector in the system responds with a reading that is below or above normal limits, then the system will enter the trouble mode, and the particular Intelligent Detector will be annunciated on the system display, and printed on the optional system printer. This feature shall in no way inhibit the receipt of alarm conditions in the system, nor shall it require any special hardware, special tools or computer expertise to perform.

The system shall include the ability (programmable) to indicate a "pre-alarm" condition. This will be used to alert maintenance personal when a detector is at 80% of its alarm threshold in a 60 second period.

15.2.17 **Network Repeater Panel**

The NRP shall include a minimum of 6 inch or 160 characters, backlit by a long life, solid state LCD display. It shall also similar as Main Fire Alarm Panel. Additionally, the network display shall include soft-keys for screen navigation and the ability to scroll events by type. i.e. Fire Alarm, Supervisory Alarm, Trouble, etc.

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

The NRP shall mount in any of the network node fire alarm control panels. Optionally, the network display may mount in a backbox designed for this use. The network shall support a minimum of 50 network control annunciators (not to exceed total node capacity) and shall connect to the network over either a wire or fiber interface.

The network control annunciator shall have an event history buffer capable of storing a minimum of 4000 events in non-volatile memory. Additionally, the NRP shall have a fire alarm history buffer capable of storing a minimum of 500 events in non-volatile memory. Systems that do not protect fire alarm events from being overwritten by other events are not suitable substitutes.

The network control annunciator shall include control switches for system wide control of Acknowledge, Signal Silence, System Reset, Drill, and local Lamp Test. A mechanical means by which the controls switches are "locked out", such as a key, shall be available.

The NRP shall include long life LEDs to display Power, Fire Alarm, Pre-Alarm, Security Alarm, System Trouble, Supervisory, Signals Silenced, Disabled Points, Other (non-fire) Events, and CPU Failure.

The network control annunciator shall include a Master password and up to Four User

passwords. Each password shall be up to eight alpha-numeric characters in length. The Master password shall be authorized to access the programming and alter status menus. Each User password may have different levels of authorization assigned by the Master password.

The NRP shall allow editing of labels for all points within the network; control on/off of outputs; enable/disable of all network points; alter detector sensitivity; clear detector verification counters for any analog addressable detector within the network; clear any history log within the network; change the Time/Date settings; initiate a Walk Test.

15.2.18 **Network Control Station**

A PC based graphical facilities monitoring system shall be installed in accordance to the project specifications and drawings.

The PC based graphical facilities monitoring system shall include, but not be limited to, one or more PC based graphical workstations, all input/output devices, network communications media, control equipment, auxiliary control devices, power supplies, and wire
/ fiber optic media as shown on the drawings and specified herein.

A supervised interface to fire alarm control panels shall be made available.

The system shall employ an advanced technology network to monitor and control various fire, security, and CCTV and other facility information over a Lon Works network.

The system shall include an interface to digital alarm communicator receivers for wide area network monitoring.

The system shall allow a mixture of different technologies and manufacturers' equipment to operate on the same network and provide the operator with a consistent look and operation for all monitored equipment.

The system shall support a variety of topologies and media and shall provide an industry standard open architecture transport layer protocol.

Using standard RS 485 ports on existing and future monitoring and control systems used by the facility, the system shall connect to and interpret status change data transmitted from the ports and provide graphic annunciation, control, history logging and reporting as specified herein.

Proprietary network systems that cannot interface to existing addressable fire alarm systems at the facility or systems requiring the use of a "dry contact" or "voltage monitoring" interface shall not be accepted.

The system shall be electrically supervised and monitor the integrity of all conductors.

15.2.19 **Workstation Performance**

The network will interface and report the individually monitored system's status via a user-friendly Graphical User Interface (GUI) based software workstation.

The software shall operate under Microsoft® Windows® 10/ XP Professional as manufactured by Microsoft Corporation.

The GUI based software must be capable of graphically representing each facility being monitored with floor plans and icons depicting the actual locations of the various systems; and / or sensors' locations.

The software shall use a 1024 X 768 GUI display capable of showing a large primary floor plan display, a key map representative of a larger view of the primary display and its relationship to the facility being monitored, the current operator, number of fire, supervisory, pre-alarms, troubles, and security events within the network as well as outstanding events and acknowledged events.

The workstation shall have the ability to support graphic printing of all data including graphical floor plans, system activity, history, and guidance text. A Windows compatible printer shall be supported for the graphics and report printer options.

The workstation software shall permit automatic navigation to the screen containing an icon that represents the system or sensor in the event of an off-normal condition.

The system/sensor icon shall indicate the type of off-normal condition and shall flash and change to the color associated with the off-normal condition (e.g., RED for ALARM and YELLOW for TROUBLE).

The software shall allow the attachment of text (TXT) files, sound (WAV) files, image (BMP) files and video (AVI) files to each system or sensor icon allowing additional information to be provided to the system operator for responding to the off-normal condition.

The software shall allow the importation of externally developed floor plans in Windows Metafile (WMF), JPEG (JPG), Graphics Interchange Format (GIF) and Bitmap (BMP) format.

The software shall provide auto-navigation to the screen containing the icon of any system or sensor when an event is initially annunciated. In addition, operator navigation to screens containing outstanding events shall be accomplished by “clicking on” the event from either the acknowledged or unacknowledged event.

History Manager: The software shall contain a History Manager, which shall record all system events with a time and date stamp as well as the current system operator’s name.

a. The system shall provide for the ability to store all off-normal events experienced by the various sub-systems that are monitored by the system.
b. All events shall be recorded with a time and date stamp and the system operator shall be provided with the ability to log a pre-defined response or a custom comment for each off- normal event and have that comment stored in the history file with the time, date and operator name.
c. Provide for the ability to conduct searches and generate subsequent reports, based on all events for a single system / device address, a specific node, a specific type of off-normal condition and date range (mm/dd/yy to mm/dd/yy) or combinations of these search parameters. The number of entries in the history file that match the determined search criteria will be displayed.
d. The History Manager shall signal a need to back-up the history file at 100,000 events and then remind the operator at intervals of 100 events thereafter.
e. It shall be possible to pre-select data fields for reporting and then saving the report as a template with a file name. It shall also be possible to schedule the pre-defined report to print at a designated time.

Alarm Monitoring: The system shall provide for continuous monitoring of all off-normal conditions regardless of the current activity displayed on the screen.

a. If an operator is viewing the history of a sub-system and an alarm condition should occur, the system shall automatically navigate to the graphic screen showing the area where the off-normal event is occurring.
b. The system shall prioritize all off-normal events as defined by Underwriter’s Laboratories into the following categories: fire alarms, troubles, supervisory alarms, pre- alarms and security alarms.
c. The system shall display a running count of all events by type in an alarm event counter window. The event counter window shall include five counters, defaulted to Alarm, Trouble, Security, and Supervisory events.
d. The system shall show a running list of all unacknowledged events and acknowledged events and allow the system operator to acknowledge an event by “double-clicking” on that event in the Unacknowledged Events box. The Unacknowledged and Acknowledged Events boxes shall contain an abbreviated description of the off-normal condition.
e. The details of the condition may be viewed by selecting event in the unacknowledged events box.

f. The system shall allow the attachment of user-definable text files, image files and sound files, to each device / system monitored in order to facilitate the operators and response personnel's response to the off-normal condition.

g. The system shall record all events to the system's hard drive. A minimum of 100,000 events may be stored.

Reports & Logs:

1. The system shall provide for the ability to generate reports based on system history.

2. The system shall allow the system operator to enter custom comments up to 255 characters for each event and have those comments recorded in the system's history file.

Boolean Logic

1. An automated event response application shall be provided to automatically perform actions across the entire system based on network activity.

2. The event response application shall allow event responses (actions) based on predefined

3. Actions shall be configured to be executed immediately or timed as

required. Control Aspects of System Software:

1. The system shall provide for the direct control of all outputs associated with Input / Output dry contact relay points on Network Input/Output Nodes (NIONs). In addition, the system shall have the ability to control and program a sub-system Fire Alarm Panel through a terminal mode window (ASCII terminal type connection) interface to microprocessor-based sub-systems via an RS 232 serial NION if available as an ancillary feature.

2. The system shall have the ability to monitor and control Fire Alarm Panels:

3. Discrete I/O NION interfaces allow the system operator to initiate a change of state for the associated dry contacts.

4. A scheduling utility shall be included with the workstation to configure the I/O points on these NIONs for automated activate/deactivate, and Arm/Disarm (depending on device type) status.

5. The workstation shall provide configuration utilities for monitoring and control profiles. These profiles shall be user definable for distribution of monitoring and control allowances for operators per workstation.

6. Terminal mode interfaces using serial NIONs (if available for the specific system) shall be available to allow full programming and control of the system being monitored and shall provide the operator with the ability to take advantage of all features supported by a CRT attached to the associated individual sub-system.

7. Under no condition shall any sub-system be required to rely on the network for any data processing required to perform its particular function. Each individual sub-system shall be in effect "stand-alone" as to insure it's continued operation should a disruption in communication with the system be experienced.

The software shall be password protected and provide for the definition of security profiles for operator access control.

The software shall contain provision for defining monitoring profiles of pre-selected NIONs for monitoring. This shall include provision for status types within the selected NODES.

The software shall contain provision for defining control profiles of pre-selected NIONs for control.

1. The system administrator shall be povided means to select which signals can be controlled by selected Workstation.

The software shall support live voice paging for mass notification to voice evacuation

system over Internet Protocol (IP).

15.2.20 **Workstation**

A. The system shall be a Facilities Monitoring System.

B. The system shall operate on an UL listed Intel Pentium III processor operating at no less than 800 MHz on the Microsoft® Windows® XP Professional platform.

C. The workstation shall have: no less than 256 megabytes of RAM, a hard drive with no less than 20 Gigabytes of storage space, a minimum of 8 megabytes of video RAM, a CD-R/W for system backup, internal supervisory CPU watchdog board with audible annunciator, 100 Base-T Ethernet NIC card, a 104 key keyboard, and a mouse type pointing device.

D. The workstation shall come equipped with all necessary gateway modules to allow connection to the network it monitors as standard equipment. All workstations shall support Ethernet communications when multiple workstations are required.

E. The workstation shall support an SVGA monitor and be supplied with a 17" flat screen LCD monitor.

F. The computer shall be capable of networking to additional computers and these computers shall be capable of operating as workstations and/or gateways for local area or wide area networks.

G. Alarm annunciation shall appear on all workstations and may be silenced at each local workstation.

1. Only one workstation and operator shall be in command of the system for global alarm acknowledgement at any time.

15.2.21 **Monitoring Network**

A. The network shall have the ability to use fiber optic cable (single-mode and multi- mode), wire (twisted pair copper media in a style 4 or style 7 configuration), or combination wire/fiber communications with support of up to 63 nodes.

1. Wire networks shall support 12 AWG, 1 Pair Shielded to 24 AWG, 4 Pair Unshielded following the manufacturer's guidelines.

2. Fiber optic networks shall support 62.5/125µm cable 8dB limit (50/125µm cable 4.2dB limit).

3. Wire to fiber conversions using repeaters.

C. True peer-to-peer communications.

D. Workstation Network:

1. Computers shall be networked using Ethernet supporting the use of TCP/IP protocol for local area systems.

2. The network shall be capable of supporting multiple clients (e.g., workstations, configuration applications, automated response applications) and up to ninety-nine (99) gateways.

3. A UL listed Ethernet Hub shall be provided for connection of multiple workstations, gateways, clients, and/or network printers.

4. System shall be UL listed to communicate between clients and gateways over a business computer network (shared IP).

15.2.22 **Signaling Line Circuits (SLC)**

Each FACP or FACP network node shall support up to two SLCs. Each SLC interface shall provide power to and communicate with minimum 250 detectors,& devices in any combination. Each SLC shall be capable of NFPA 72 Style 4, Style 6, or Style 7 (Class X, Class A or B) wiring.

CPU shall receive analog information from all intelligent detectors to be processed to determine whether normal, alarm, prealarm, or trouble conditions exist for each detector. The software shall automatically maintain the detector's desired sensitivity level by adjusting

for the effects of environmental factors, including the accumulation of dust in each detector. The analog information shall also be used for automatic detector testing and for the automatic determination of detector maintenance requirements.

The system shall include an RS-485 port for the serial connection of optional annunciators and remote LCD displays.

The RS-485 interface may be used for network connection to a proprietary-receiving unit. Notification Appliance Circuit (NAC) Module

The Notification Appliance Circuit module shall provide four fully supervised Class A or B (NFPA Style Z or Y) notification circuits. An expansion circuit board shall allow expansion to eight circuits per module.

The notification circuit capacity shall be 1.0 amperes maximum per circuit and 2.0 amperes maximum per module.

The module shall not affect other module circuits in any way during a short circuit condition. The module shall provide eight green ON/OFF LEDs and eight yellow trouble LEDs.

The module shall also provide a momentary switch per circuit that may be used to manually turn the particular circuit on or off or to disable the circuit.

Each notification circuit shall include a custom label inserted to identify each circuit's location. Labels shall be created using a standard typewriter or word processor.

The notification circuit module shall be provided with removable wiring terminal blocks for ease of installation and service. The terminal strips shall be UL listed for use with up to 12 AWG wire.

Each circuit shall be capable of, through system programming, deactivating upon depression of the signal silence switch.

Waterflow Operation

An alarm from a waterflow detection device shall activate the appropriate alarm message on the main panel display, turn on all programmed notification appliance circuits and shall not be affected by the signal silence switch.

Supervisory Operation

An alarm from a supervisory device shall cause the appropriate indication on the system display, light a common supervisory LED, but will not cause the system to enter the trouble mode.

Signal Silence Operation

The FACP shall have the ability to program each output circuit (notification, relay, speaker etc) to deactivate upon depression of the signal silence switch.

Sprinkler and Standpipe Valve Supervisory Switches:

Each sprinkler system water supply control valve riser, zone control valve, and standpipe system riser control valve shall be equipped with a supervisory switch. Standpipe hose valves, and test and drain valves shall not be equipped with supervisory switches.

PIV (post indicator valve) or main gate valves shall be equipped with a supervisory switch. The switch shall be mounted so as not to interfere with the normal operation of the valve and adjusted to operate within two revolutions toward the closed position of the valve control, or when the stem has moved no more than one-fifth of the distance from its normal position. The supervisory switch shall be contained in a weatherproof aluminum housing, which shall provide a 3/4 inch (19 mm) conduit entrance and incorporate the necessary facilities for attachment to the valves.

The switch housing shall be finished in red baked enamel.

The entire installed assembly shall be tamper proof and arranged to cause a switch operation if the housing cover is removed, or if the unit is removed from its mounting.

Valve supervisory switches shall be provided and connected under this section and

installed by mechanical contractor.

Non-Alarm Input Operation

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

Combo Zone

A special type code shall be available to allow waterflow and supervisory devices to share a common addressable module. Waterflow devices shall be wired in parallel, supervisory devices in series.

15.2.23 **Addressable Devices**

Addressable devices shall use simple to install and maintain decade, decimal address switches. Devices shall be capable of being set to an address in a range of 001 to 150. How ever electronic addressing will be accepted only if all the devices can be fully programmed for sensitivity settings, pre alarm level etc from the panel with no extra programming tools and computer shall be used.

Detectors shall be intelligent (analog) and addressable, and shall connect with two wires to the fire alarm control panel Signaling Line Circuits.

Addressable smoke and thermal detectors shall provide dual alarm and power/polling LEDs. Both LEDs shall flash green under normal conditions, indicating that the detector is operational and in regular communication with the control panel, and both LEDs shall be placed into steady red illumination by the control panel, indicating that an alarm condition has been detected. If required, the LED flash shall have the ability to be removed from the system program. An output connection shall also be provided in the base to connect an external remote alarm LED.

The fire alarm control panel shall permit detector sensitivity adjustment through field programming of the system. The panel on a time-of-day basis shall automatically adjust sensitivity.

Using software in the FACP, detectors shall automatically compensate for dust accumulation and other slow environmental changes that may affect their performance. The detectors shall be listed by UL as meeting the calibrated sensitivity test requirements of NFPA Standard 72, Chapter 7.

The detectors shall be ceiling-mount and shall include a separate twist-lock base with tamper proof feature. Bases shall include a sounder base with a built-in (local) sounder rated at 85 DBA minimum, a relay base and an isolator base designed for Style 7 applications.

The detectors shall provide a test means whereby they will simulate an alarm condition and report that condition to the control panel. Such a test may be initiated at the detector itself (by activating a magnetic switch) or initiated remotely on command from the control panel.

Detectors shall also store an internal identifying type code that the control panel shall use to identify the type of device.

Detectors will operate in an analog fashion, where the detector simply measures its designed environment variable and transmits an analog value to the FACP based on real-time measured values. The FACP software, not the detector, shall make the alarm/normal decision, thereby allowing the sensitivity of each detector to be set in the FACP program and allowing the system operator to view the current analog value of each detector.

Addressable devices shall store an internal identifying code that the control panel shall use to identify the type of device.

A magnetic test switch shall be provided to test detectors and modules. Detectors shall report an indication of an analog value reaching 100% of the alarm threshold.

Addressable modules shall mount in a 4-inch square (101.6 mm square), 2-1/8 inch (54 mm) deep electrical box. An optional surface mount Lexan enclosure shall be available.

i. Programmable Electronic Exit Point Sounders:

Shall follow NFPA 72 2007 edition

recommendation. Electronic sounders shall

operate on 24 VDC nominal.

Electronic sounders shall be field programmable without the use of special tools, at a sound level of at least 90 dBA measured at 10 feet from the device.

Shall be capable to broadcast pre programmed Voice Message also

Shall be flush or surface mounted as shown on plans.

Shall produce broad band directional sound with 20 Hz to 20 Khz frequency band to guide occupants to safe exists even in complete darkness.

ii. Strobe lights

shall meet the requirements of the ADA, UL Standard 1971, be fully synchronized, and shall meet the following criteria:

The maximum pulse duration shall be 2/10 of one

second. Strobe intensity shall meet the requirements

of UL 1971. The flash rate shall meet the requirements

of UL 1971.

iii. Field Wiring Terminal Blocks

For ease of service all panel I/O wiring terminal blocks shall be removable, plug-in types and have sufficient capacity for #18 to #12 AWG wire. Terminal blocks that are permanently fixed are not acceptable.

iv. Addressable Manual Fire Alarm Box (manual station)

Addressable manual fire alarm boxes shall, on command from the control panel, send data to the panel representing the state of the manual switch and the addressable communication module status. They shall use a key operated test-reset lock, and shall be designed so that after actual emergency operation, they cannot be restored to normal use except by the use of a key.

All operated stations shall have a positive, visual indication of operation and utilize a key type reset.

Manual fire alarm boxes shall be constructed of Lexan with clearly visible operating instructions provided on the cover. The word FIRE shall appear on the front of the stations in raised letters,
1.75 inches (44 mm) or larger.

v. Intelligent Multi Criteria Detector

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

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

moved or as the occupancy changes).

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

vi. Addressable Control Module

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

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

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

The control module shall be suitable for pilot duty applications and rated for a minimum of 0.6 amps at 30 VDC. Addressable Control modules shall provide built-in, intelligent dual isolation, and meets Class X (Style 7) wiring requirements. Up to 190 isolators per loop and up to 30 devices between isolators (wired in polarity-insensitive mode). The isolation feature found on Intelligent Interface Modules gives information as to the location of the fault. When a short occurs, the panel can identify the fault automatically, and the module recognizes the short location (in front of the device or behind the device).

vii. Addressable Relay Module

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

viii. Isolator Module

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

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

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

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

The isolator module shall not consume any detector or device address from the loop

capacity. Pipe Sections

Smoke tests should be performed before planning and

Installing the pipe network.

Material

ABS or UPVC, copper or stainless steel may also be used if required.

15.2.24 **Batteries:**

The battery shall have sufficient capacity to power the fire alarm system for not less than twenty-four hours plus 5 minutes of alarm upon a normal AC power failure.

The batteries are to be completely maintenance free. No liquids are required. Fluid level checks for refilling, spills, and leakage shall not be required.

If necessary to meet standby requirements, external battery and charger systems may be used.

The Unit shall be UL / FM / VDS approved.

15.2.25 **Fire Survival Cable:**

Conduit:

Conduit shall be in accordance with The National Electrical Code (NEC), local and state requirements.

Where required, all wiring shall be installed in conduit or raceway. Conduit fill shall not exceed 40 percent of interior cross sectional area where three or more cables are contained within a single conduit.

Cable must be separated from any open conductors of power, or Class 1 circuits, and shall not be placed in any conduit, junction box or raceway containing these conductors, per NEC Article 760-29.

Wiring for 24 volt DC control, alarm notification, emergency communication and similar power- limited auxiliary functions may be run in the same conduit as initiating and signaling line circuits. All circuits shall be provided with transient suppression devices and the system shall be designed to permit simultaneous operation of all circuits without interference or loss of signals.

Conduit shall not enter the fire alarm control panel, or any other remotely mounted control panel equipment or back boxes, except where conduit entry is specified by the FACP manufacturer. Conduit shall be minimum 25 mm.

Wire:

All fire alarm system wiring shall be new & Low Smoke Zero Halogen Silicon Insulated Fire Survival Cable with Drain Wire Armouring, solid copper conducter cable approved by LPCB as per BSEN 50200:2015 PH 120 (Fire, Mech Shock & Water 120 Minutes @ 830 deg Celcius, Fire & Mech Shock every 5 Min for 2 Hours- Both test conducted on same sample) and BS- 6387 CWZ The cable shall sustain 950 deg. C. For 3 hours approved along with accessories/ termination glands and all necessary materials to complete. The cable shall be approved for BS EN 60332-1-2:2004 for Bunched Flame Retardancy (installed as a single or bunched cable self extinguishes leaving the upper cable sheath unaffected showing the cable does not propagate fire). Cable shall be guaranteed for 10 years from the date of manufacture marked on the cable.

Number and size of conductors shall be as recommended by the fire alarm system manufacturer, but not less than 0.5 sq mm for Initiating Device Circuits and Signalling Line Circuits, and 1.5 sq mm for Notification Appliance Circuits. All wire and cable shall be listed and/or approved by a recognized testing agency for use with a protective signalling system.

Wiring used for the loop circuit shall be twisted and shielded and support wiring distance up to 3.5 KM. All field wiring shall be electrically supervised for open circuit and ground fault.

15.3 INSTALLATION, TESTING & COMMISSIONING:

15.3.1 **Installation:**

Installation shall be in accordance with the NEC, NFPA 72, local and state codes, as shown on the drawings, and as recommended by the major equipment manufacturer.

All conduit, junction boxes, conduit supports and hangers shall be concealed in finished areas and may be exposed in unfinished areas. Smoke detectors shall not be installed prior to the

system programming and test period. If construction is ongoing during this period, measures shall be taken to protect smoke detectors from contamination and physical damage.

All fire detection and alarm system devices, control panels and remote annunciators shall be flush mounted when located in finished areas and may be surface mounted when located in unfinished areas.

Manual fire alarm boxes shall be suitable for surface mounting or semi-flush mounting as shown on the plans, and shall be installed not less than 42 inches (1067 mm), nor more than 48 inches (122 mm) above the finished floor.

15.3.2 **Testing:**

The service of a competent, factory-trained engineer or technician authorized by the manufacturer of the fire alarm equipment shall be provided to technically supervise and participate during all of the adjustments and tests for the system. All testing shall be in accordance with NFPA 72, Chapter 7.

Before energizing the cables and wires, check for correct connections and test for short circuits, ground faults, continuity, and insulation.

Close each sprinkler system flow valve and verify proper supervisory alarm at the

FACP. Verify activation of all waterflow switches.

Open initiating device circuits and verify that the trouble signal actuates.

Open and short signaling line circuits and verify that the trouble signal actuates.

Open and short notification appliance circuits and verify that trouble signal

actuates. Ground all circuits and verify response of trouble signals.

Check presence and audibility of tone at all alarm notification devices.

Check installation, supervision, and operation of all intelligent smoke detectors using the walk test.

Each of the alarm conditions that the system is required to detect should be introduced on the system. Verify the proper receipt and the proper processing of the signal at the FACP and the correct activation of the control points.

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

15.3.3 **Final Inspection:**

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

15.3.4 **Instruction:**

Instruction shall be provided as required for operating the system. Hands-on demonstrations of the operation of all system components and the entire system including program changes and functions shall be provided.

The contractor and/or the systems manufacturer's representatives shall provide a typewritten "Sequence of Operation."

The entire Fire Alarm System components shall be of same make and Listed. The data sheets of each equipment shall be submitted along with the offer.

16. PUBLIC ADDRESS AND VOICE ALARM SYSTEM

16.1 GENERAL:

The contractor shall supply, install, test, connect and commission a high quality fast-acting Public Address and Voice Alarm System complying strictly with BS 5839 part8 and EN60849 and shall be TUV or Equivalent Agency approved. The Public Address and Voice Evacuation System shall comprise of Audio Matrix Units, High quality speakers, Audio rack all mounted on a 19" Rack and fully connected and integrated on the fire alarm loop. The system shall be used for Professional Sound Reproduction for all the areas where possible special events take place.

Prior to placing order for any equipment, the contractor shall submit comprehensive document comprising working drawings, catalogues and descriptive literature of components, acoustic calculation to meet with BS5839 part8 RASTI (Room Acoustic Speech Transmission Index) requirements of 0.5 on the STI scale and 0,7 on the CIS scale. The contractor shall be required to train and instruct client's personnel in the correct use, operation and supervision of the system, preferably prior to the handing over of the project.

In order to ensure whole site integration capability, the fire and voice alarm system will be awarded to a single specialist local supplier who will be responsible for the design, global operation, management and interfacing of the system. The contractor shall make sure that all power tapping of the speakers must be carried out as specified, even if the acoustic calculations indicates less power tapings. The contactor must endure minimum of 10dB above the ambient noise levels are achieved.

The system shall be fully programmed to accommodate fire alarm and voice communication zones as indicated on the drawings and schematics. The system shall be configured to allow on site modifications with the minimum of disruption using the PC based software to facilitate future changes or alterations to the buildings.

16.2 APPLICABLE STANDARDS:

EVAC Compliant with IEC/EN60849

Loudspeakers -Rated power IEC 60286-Part 5

Tested in accordance with BSEN60268-5

Acoustic models ready for CATT, ULYSSES & EASE

Compliant with BS5839 Part 8

Battery backup/charger compliant with EN54 part 4.

The PA system is designed to serve the dual purpose of making general announcement and Voice Evacuation at the time of Fire alarm activation.

16.3 SYSTEM DESIGN:

The PAVA system shall be connected on the same Fire Alarm loop with in-built isolators to protect the system in case of any cable faults. The system shall be de-centralized in nature, each distributed rack DAU (Distributed Amplifier Unit) shall have all the DSP (Digital Signal Processing), messages, amplifiers, monitoring in such a way that can work in a stand-alone mode in case the master rack is faulty or down.

The Man Machine Interface (MMI) shall be connected back to the control room, to monitor and control the entire PAVA system. The MMI shall be fully BS5839 part 8 and EN60849 compliant and TUV approved. The DAU shall play background / Foreground music and in case of Fire Alarm / Paging announcement, the system shall go to full power as programmed to provide the enough SPL (Sound Pressure Level) levels to comply with BS5839 part8, with minimum of 10dB above the noise levels.

All system components shall be digitally monitored including and not limited to, Messages,

Amplifiers, and back up amplifiers, Speaker Circuits, Audio Matrix units, Paging Microphone, Battery Charger and the 230VAC line. Each amplifier / line circuit shall be monitored individually and shall report any faults back to the Master Audio Matrix Unit as well as the Paging Microphone.

There shall be one back up amplifier, the system shall automatically change over to the back up in case of any amplifier failure, and the back up amplifiers shall be monitored as well.

The Battery Back up shall provide 24 hours of back up and 30 min of alarm operation. The power supply / charger must comply with EN54 part 4 and shall be 19" rack mounted. Battery calculation must strictly comply with BS5839 part 8 and shall be based on the amplifier size and not the speaker circuit load.

The PAVA system shall be properly integrated with the fire alarm system. The integrated PAVA system shall cover all normally accessible areas including the car parks.

In addition, a FIRE DRILL, BOMB ALERT, EARTHQUAKE ALERT and an ALL CLEAR message shall be incorporated into the operation. A fire alarm broadcast signal shall cancel any public-address operation and shall override it. When a fireman's microphone is operated, this shall override any automatic voice alarm signal being transmitted to the zone selected.

All amplifier gain shall be monitored and measured for open, short or earth faults. The Entertainment Rack shall be located in the Control/Security Room enabling the operator to select music from the CD player, FM tuner or the double cassette deck to transmit music to selected zones or all the zones in the building from the touch screen paging microphone. A public-address announcement shall override the music transmission to selected zones or all zones. The Speakers shall be distributed in the entire floor and shall be configured in different zones. The announcement can have made in zone wise or to all the speakers simultaneously in ALL CALL mode. Fire Alarm shall be announced immediately on receipt of Fire signal from the panel to all zones or group of Zones.

System shall have following functions:

Voice Evacuation and Public Address system integration includes paging system and background music system.

Monitoring of microphone, controller, amplifier, fireman microphone, and source modular, AC&DC power Supply, and Volume Control.

The Amplifier shall be used only Class-D with Digital switching power technology.

16.3.1 **Amplifiers**

All amplifiers shall be power amplifier with High quality speech and Music broadcast. The power amplifiers shall have adequate continuous (RMS) power output to meet the requirement of the configuration. The unit shall can deliver the rated output power with less than 0.1% harmonic distortion in the design bandwidth. The amplifier shall have a broad band frequency response of 20 Hz to 20 KHz. The output voltage and impedance shall meet with the system requirements. Amplifiers shall be protected against over loads and output shorts and a special thermal overload on the heat sink.

The Amplifier shall be Class –D Amplifier have one channel, Two Channel, Three Channel and four channels' each channel have rated power as per approved design . The Amplifier shall have switch power technology for power electricity saving, sleep mode is automatically enabled when no signal input is detected.

Amplifier shall have AC 115V or 230V power supply and DC 24V input, having separate fuse for each channel. The Amplifier shall be connected through balanced audio input and shall work on 100V Speaker Line.

Technical Specifications:

Rated Output Voltage(RMS) as per approved

design Amplification	Class-D
Battery Voltage	24VDC (max 10%
déviation) Frequency Response	20Hz to 20KHz
S/N Ratio	>80 dB
Total Harmonic Distortion	<0.1% @ 1kHz
Power Efficiency	>75%
Approval	EN

16.3.2 **Speakers**

Speakers shall be especially designed for broadcasting high quality, integrated emergency fire alarm signals and voice communications and approved by an appropriate authority for use in such situations.

Speakers shall be ceiling, wall mounted or Horn Speaker as shown in the schedule of work and shall be completed with mounting brackets, accessories etc. Speakers shall be in metal enclosures only.

Speakers shall be interconnected in the zone configuration.

i. 6W Ceiling Mounted Speaker:

The ceiling mounted 6 W speakers shall be installed as depicted in the drawing. The speakers support EASE, CATT or ULYSSES models for acoustic studies. This means the acoustic model can be designed to simulate sound quality and distortion prior to installation. The Speaker should be in compliance BS/EN 60065, 2003 and EMC (BS EN 61000-6-Part 1/2/3/4). The Ceiling speaker shall work on 100V line so that it can reduce line losses over long distance and allow easy parallel connection of multiple loudspeakers. The Speaker shall have multiple tapping for different applications according to room size and ambient noise environment. The Speaker shall have aluminum grille and metal baffle and shall have spring clip clamp for easy installation.

Technical Specifications:

Rated power	6 W
Tapings 100V line	6/3/1.5W
Operation Voltage	100V or 70V
Effective frequency range	110 ~ 15kHz
SPL @ 1W/m	>91 dB
S.P.L. ,@Full power/ 1m, dB	>97 dB
Speaker Drive	6”
Color	White
Ceiling Cut-out	170mm
Dimensions	200 mm x 65 mm

ii. 10W Wall Mounted Speaker:

Rated power	10 W
Effective frequency range	150 ~ 15kHz
Sensitivity	98dB
Power Handling	10W
Line Input	100V
Component	6.5”

Material	ABS
Grille	Power coated Iron mesh
Color	White
Dimensions	200 mm x 105mm x 275mm

iii. 15W Horn Speaker:

The Horn speakers with 15W Output shall be installed as depicted in the drawing. The speakers support EASE, CATT or ULYSSES models for acoustic studies. This mean the acoustic model can be designed to simulate the sound quality and distortion prior to installation. The Speaker should be complying BS/EN 60065, 2003 and EMC (BS EN 61000-6- Part 1/2/3/4). The Horn speaker shall work on 100V line so that it can reduce line losses over long distance and allow easy parallel connection of multiple loudspeakers. The Speaker shall have multiple tapping for different application per room size and ambient noise environment.

Technical Specifications

Rated power	15 W
Tapings 100V line	15W/7.5W
Operation Voltage	100V or 70V
Effective frequency range	250 ~ 8kHz
SPL @ 1W/m	>103 dB
S.P.L. ,@Full power/ 1m, dB	>113 dB
Color	White
IP Rate	IP 66
Dimensions	282 x 210 x 290mm

16.3.3 **Remote Paging Microphone**

The Remote Paging Microphone should be fully digital connected via CAT6 Cable with Controller. The Microphone should have capability to make announcement in 8 Zones and have all call facility. The Microphone shall have ability to control music and should be able to route the music in zones. Microphone should have maximum zones capacity up to 120 Zones. The Microphone should have LED indication for the different faults, the unit shall be able to indicate AC, DC, Fault, Mic and Test status through LED. The Microphone shall have 6 input & Mic/line Selection buttons. The unit shall have 12 Selection buttons with three colored indicators. The Microphone have reset/channel, All call & Call buttons. The Unit shall have 2 RJ45 ports for Microphone so that the other microphone shall be able to link with the unit. The Microphone shall have Ability to Communication limit up to 600 Meters

The Microphone shall have following features:

AC 230V and DC24V battery

inputs. Built-in monitor speaker.

Paging mode:	PTT & Normal paging
Phantom Power:	20V – 27.5V
Power Consumption:	< 2.4A
Line input Sensitivity:	775

mV Microphone input Sensitivity:

5 mV S/N ratio:

>70

dB

Humidity: <95%

16.3.4 **Voice Alarm Controller (VAC)**

The network controller shall be a control unit for a public address and emergency sound system. It shall control and route audio channels on a CAT6/fiber network, with audio signals comprising e.g. announcements made via call stations or background music from a connected CD-player. The network controller shall have an RJ-45 Ethernet connection for connecting a configuration PC, directly or via an Ethernet network. After the configuration, the network controller shall be able to run stand-alone without PC, although it shall be possible to keep the network controller connected to the network or PC for additional functions, such as logging of

call and fault events or remote control. The network controller shall provide power to connected equipment on the network. It shall provide 6 analog audio input channel.

The controller shall have a supervision system to monitor its operation conditions. Network connectivity status and fault conditions of the network controller itself and all network-connected units shall be stored inside the network controller. The network controller shall have

8 control inputs for activation switches, with configurable for open and short circuits. The control inputs shall have configurable functionality, such as automatically starting an emergency alarm in case of activation by a fire alarm. The network controller shall have relay outputs that can be configured for integration with the third party. The Network controller should have 2 Separate players for alert and EVAC and should have SD Card to store the prerecorded messages. The Controller shall have message recording in following format MP3 or WMA format, two separate players of SD card with protection cover, programmable voice message up to 255.

The unit shall be able to operate at a maximum operating temperature of 55°C to accommodate high density rack mounting. The network controller shall be as per the international standard IEC 60849 for emergency sound systems. The unit can be free-standing on a tabletop or mounted in a 19" rack.

The following features shall be available or supported by Network

controller. The Controller shall have Class-D 500W Digital amplifier

EN54 Approval for the controller

The controller shall comply standards of BS EN54-32 & EN608409.

Controller should have EN54 Certified

8 zone AB speaker line low impedance supervision.

Red button EVAC message push to activate with priority except fireman

mic. 8 zone speaker outputs.

8 zone separate indicator for EVAC, fault, music/paging & select.

System indicators of AC, DC, fault and indicators for EVAC, alert & fireman mic.

Zone capacity of 120 zones by cascaded routers.

Priority level: fireman mic, EVAC, input 1, remote microphone, timer & BGM.

Two RJ45 for cascade router, two RJ45 for remote microphone input and two RJ45 for LAN/WAN/Internet network.

AC 230V and DC24V battery input. Auto switch into the battery backup when AC fails.

Technical Specification:

Power Supply	AC 220V – 250V/24VDC, 50/60Hz
Power Consumption	650W

Fireman Impedance	600Ohm
Fireman Microphone:	5mV, 600 Ohm
Line 1 – 2 input:	385mV
Frequency Response:	80Hz – 20kHz
Line 3 – 6 input:	350mV
THD	<0.1%
S/N Ratio	>70dB
Relative Humidity	95%

16.3.5 **Software**

PAVA Software with following Features: Should be connected with CAT5 Cable, Shall provide Zone control, status monitor, Offline Program, Event Recording, System Configuration, User Management. Software shall allow automatically playing and timing function to achieve timing programmed playing in the designated zones for unattended operation, Built-in Automatic Timing Corrector. Support Export and Import easily to save Data.

16.3.6 **Digital AM/FM Tuner**

The digital AM/FM tabletop and rack mount design with aluminum alloy panel. It shall have clearly visible LDC display, microcomputer control and touch-button operation. FM/AM two band receive option, FM receiving frequency 76MHz – 108MHz, AM receiving frequency 520Hz – 1708 KHz. Radio frequency automatic search and memory function, memory up to 99 bands and a power off memory functions. Using vehicle dedicated digital radio module, integrated radio tuner module, with a small size good performance and strong anti – interference etc.

Built in High fidelity wideband monitor Speaker, Sound full and clear, and a monitor with adjustable volume knob

Technical Specifications:

Power Supply 220V/50Hz

Power Consumption 8W

1 Channel audio signal left and right channel output

16.3.7 **CD/DVD Player**

The CD/DVD player shall be capable playing MP3 audio tracks from USD or DVD or CD.

Technical Specifications:

D/A converter24 bit, 192 kHz

Frequency response30-20000

Hz Signal to noise ratio > 90

Distortion and Noise (1kHz)> 65

dB Crosstalk (1 kHz)> 70 dB

DynamicRange (1 kHz)> 80 dB

Sound System Dolby Digital

Playback Media

CD MP3- CD MP3- DVD WMA- CD CD- R/RW
Audio CD

Compression

format MP3

Dolby

Digital

PCM

WMA

MP3 bit

rates 32 -

320 kbps

16.3.8 **19" Rack**

The equipment shall be housed in a standard rack of suitable height, with Plexiglas door or metal mesh and lock. Ventilation panels of 1U height shall be provided between each item of equipment.

Details of the proposed equipment shall be forwarded to the Consultant with performance specifications, dimensions, construction and finish for approval.

Rack should comply with ANSI/EIA RS-310-D; DIN41491; DIN41494; IEC297-2; and GB/T3047.2-92.

The Rack should have DIN Rail Mounted Terminal Blocks for termination of Speaker Zone cables on the rear.

All cables coming from Speaker zones, Call Stations, Power supply should enter from Bottom.

Rack should be installed at location which has minimum 600mm space from front & back for accessing it easily.

Rack should be installed in well ventilated room preferable Air conditioned. The unit should have Fans from top.

The unit should have Lockable Glass door at front

Dimensions

Height as per the Quantity of PA Processor &

Amplifiers Depth 600mm Deep

Width 19"

16.3.9 **Speaker Cables**

All cables associated with PA system shall be of following specifications:

The 2 core speaker cable will be connected to the speakers by screw terminals before

which it shall be crimped using 1.5 sq. mm. bootlace lugs. Care has to be taken for avoiding any single strand of wire shall not come out of Lug & screw terminals to avoid noise & leakage.

Speaker cables used should be Multi-Conductor Stranded type.

Flexible Copper Conductor of cross section 1.5 Sq. mm / 2.5 Sq. mm insulated, PVCFRLS sheathed control Cable as per IS 694.

These Cables shall be laid in G.I. Conduits concealed/surface.

16.3.10 **Call Station Cables**

Call station cables should be 4pair CAT6 STP (Shielded Twisted Pair) type, It should be crimped by RJ45 Shielded Male Connectors.

16.4 TESTING:

Sr. No.	Description	Visual	Test Readings	Documentation
1	All cables are tested for continuity, insulation, resistance etc.			√
2	System installation proper as per drawing	√		

Sr. No.	Description	Visual	Test Readings	Documentation
3	Carry out visual checks on all speakers & Processors are free from any mechanical damage, cables, inter phase modules etc.to ensure they are properly installed.	√		
4	Check for proper termination of bootlace lugs & feruling	√		
5	Check Input A/C Supply Voltage		√	
6	Check location / spacing of loudspeakers as in drawing.	√		√
7	Check Distribution of Zones as per Drawing.	√		√
8	Check full load speaker sound quality & measure Sound pressure level (SPL) in dB.	√	√	
9	Check if local loudspeakers overrides by voice messages in case of emergency evacuation.	√		√
10	If power fails, whether Voice evacuation system is working on battery supply if yes for what time		√	

11	Check if recorder messages are CLEAR, free from any noise distortion & easy to understand with Room acoustic speech transmission Index (RaSTI) value >0.5.	√	√	
12	Processor LED's and all keys are working properly	√		
13	Check for Microphone locations & the sensitivity by paging	√		√
14	Play a soft music & check sound quality	√		

17. Clean Agent Fire Suppression System

General:
This specification is for procurement of Clean agent based total flooding fire suppression system, designed with FK-5-1-12, clean agent. All requirements outlined in this specification must be completed in their entirety. These requirements, which are in accordance with the items listed in Section 2, combined with good engineering practices, shall be followed to produce a safe and effective fire suppression system.

17.1 MANDATORY BIDDING REQUIREMENTS

The Bidders should be OEM or any one the approved distributors of OEM for FK-5-1-12 system. Equipment shall be offered from single OEM only. In case of distributor is biding along with bid documents OEM authorization certificate to be submitted otherwise offer will not be qualified for this Tender.
The Bidder should have received Technical training on design, installations and commissioning of UL listed FK-5-1-12 systems from the principal and training certificates to this account from the Principals / OEM should be submitted

17.2 GENERAL DESCRIPTION

UL listed Fire Suppression Systems shall be used to suppress fires in specific hazards or equipment located where an electrically non-conductive agent is required, where agent cleanup creates a problem, where extinguishing capability with low weight is a factor and where personnel normally occupy the hazard.

Fire Suppression Systems shall be designed for the following classes of fire:

- Class A: Surface Type Fires—wood or other cellulose-type material
- Class B: Flammable liquids
- Class C: Energized electrical equipment

17.3 CODES AND COMPLIANCE

17.3.1 The design, installation, testing and maintenance of the Fire Suppression Systems, employing FK-5-1-12, shall be in accordance with the following codes, standards and regulatory bodies:

a) NFPA 2001: Standard for Clean Agent Fire Extinguishing Systems.
b) UL 2166: Standard for Halocarbon Clean Agent Extinguishing System Units
c) IS : 15493: Gaseous Fire Extinguishing System - General Requirements
d) IS : 15496 : Inspection and Maintenance of Gaseous Fire Extinguishing System
e) ANSI B1.20.1 : Standard for pipe threads, General Purpose, 1992
f) NFPA 70 - NEC – National Electrical Code
g) NFPA 72 – National Fire Alarm Code
h) VDS 2381- Fire Extinguishing system using Halocarbons
h) Requirements of the local Authorities Having Jurisdiction (AHJ)

17.3.2 The manufacturer shall meet ISO 9001 requirements for the design, production and distribution of the engineered fire suppression system.

17.3.3 All components of the total flooding suppression system shall be manufactured in India and shall be UL/VDS listed from the same OEM.

17.3.4 SYSTEM DESIGN CRITERIA

The designer shall consider and address possible Fire hazards within the protected volume at the bid stage. The delivery of the 42 Bar FK-5-1-12 agent total flooding system shall provide for the highest degree of protection and minimum extinguishing time. Sub floor and the ceiling void to be included in the protected volume.
The OEM offering UL listed system shall offer minimum design concentration of 4.5 % for Class C Fire as per NFPA 2001 & OEM offering En/VDS listed system shall offer minimum design concentration of 5.8% for Class C Fire as per VDS 2381.
The discharge time required to achieve 95% of the minimum design concentration for flame extinguishment shall not exceed ten (10) seconds.
The Offered Cylinder shall be seamless type, manufactured and tested in accordance with IS 7285 Standard and approved by PESO for their use.
Fire detection and suppression shall be from single manufacturer.

17.4 SUBMITTALS OF

17.4.1 Engineered Design Drawings

The OEM-authorized Distributor or OEM shall provide all required installation drawings per NFPA 2001.

17.4.2. Flow Calculation Reports

The system flow calculations shall be carried out on a certified UL/VDS listed software only, suitable for the particular seamless cylinder container being offered for this project. Such System flow calculations carried out for this project shall be further vetted by the OEM for its accuracy, and the only such vetted calculations shall be admissible for approval by the Consultant.

17.4.3 Installation Drawings

Four (4) sets of installation drawings for each installed engineered suppression system and one (1) set of the calculation report, owner's manual and product data sheets shall be submitted to the end-user/owner.

Upon completion of installation and commissioning acceptance, three (3) sets of "As-Built" installation drawings and One (1) set of the calculation report for each installed engineered suppression system shall be given to the owner/end-user for use and reference.

17.4.4 Operation and Maintenance Manuals

Three (3) copies of the Operation and Maintenance Manual shall be submitted after complete installation.

17.4.6 SYSTEM HARDWARE

Fire Suppression Systems shall include the following components:

17.5 PIPE AND FITTINGS

17.5.1 Distribution piping, and fittings, shall be installed in accordance with IS-15495, approved

piping standards and the engineered fire suppression system manufacturer's requirements.

17.5.2 Pipe : As per ASTM A-106, Sch 40, M. S. Seamless

17.5.3 ACTUATION HARDWARE

The Clean Agent cylinder valve assembly shall be actuated using a UL/VDS Listed electric control head (Solenoid) ,the actuator should have facility of manual actuation also.

17.5.3 DISTRIBUTION NOZZLES

Discharge nozzles shall be used to disperse the FK-5-1-12agent. The nozzles shall be made of brass with female NPT threads and available in ½" through 2" sizes. Each size shall come in two styles: 180 degree and 360 degree dispersion patterns. The nozzle coverage shall be max. 13 m x 13 m.

17.5.4 SEAMLESS CYLINDERS AND VALVE ASSEMBLES

FK-5-1-12 shall be stored in UL listed & PESO approved seamless type Cylinders. Welded cylinders are not permitted. Agent cylinder operating pressure shall be at 42Bar @ 21°C Offered Cylinder shall be manufactured and tested in accordance with IS 7285 Standard and

approved by PESO for their use.

Clean Agent storage cylinders shall be equipped with safety rupture disc and pressure gauge to display internal pressures. The gauge shall be an integral part of the equipment and shall be color-coded for fast referencing of pressure readings.

Accepted Cylinder Capacity

A. 80 liter
B. 120 liter
C. 140 liter
D. 180 liter

17.6 PRESSURE OPERATED CONTROL HEAD

UL/VDS listed Pressure operated Control Head, should allow for Pressure actuation of Clean Agent storage- FK-5-1-12 Cylinders. This should be mounted directly on top of the slave cylinder valve

17.7 MASTER CYLINDER ADAPTER KIT

UL listed The Master Cylinder Adapter Kit, should provide a means to connect the flexible actuation hose to the master & slave cylinder valve assemblies.

17.8 FLEXIBLE DISCHARGE HOSE & ACTUATION HOSE

a) UL/VDS listed Flexible Discharge Hose should route FK-5-1-12agent from the storage cylinders to the discharge piping. This hose should be connected to the discharge outlet of the Clean Agent Cylinder Valve.

b) The UL/VDS listed Flexible Actuation Hose, should be usually used in multiple Cylinder Systems

17.9 MANIFOLD CHECK VALVE

UL listed Manifold check valves should be installed at the discharge manifold in a multiple cylinder arrangement to allow removal of any Clean Agent Cylinder from the manifold while still retaining a closed System.

17.10 MANIFOLD SUPERVISORY SWITCH

UL listed Manifold Supervisory Switch, should operate from system pressure upon discharge of FK-5-1-12 gas discharge through piping network.

TECHNICAL SPECIFICATION OF FIREFIGHTING WORKS.

SECTION I

GENERAL INSTRUCTIONS

1.0 **GENERAL REQUIREMENTS**

1.1 **Scope of Work**

1.1.1 The form of Contract shall be according to the "Conditions of Contract". The following clauses shall be considered as an extension and not in limitation of the obligation of the Contractor.

1.1.2 Work under this contract shall consist of furnishing all labour, materials, equipment and appliances necessary and required. The Contractor is required to completely furnish all the Plumbing and other specialized services as described hereinafter and as specified in the Schedule of Quantities and/or shown on the Plumbing Drawings.

1.1.3 Without restricting to the generally of the foregoing, the sanitary installations shall include the following:-

C. Fire Fighting Works

a. Hydrant System

b. Sprinkler System

c. Fire Extinguishers

1.1.4 Services rendered under this section shall be done without any extra charge.

1.2 **Specifications**

1.2.1 Work under this contract shall be carried out strictly in accordance with Specifications attached with the tender.

1.2.2 Items not covered under these Specifications due to any ambiguity or misprints, or additional works, the work shall be carried out as per Specifications of the latest Central Public Works Department with upto date amendments as applicable in the contract and or as per the requirement of the client or its representative.

1.2.3 Works not covered above in para 1.2.1 and 1.2.2 shall be carried out as per relevant Indian Standards and in case of its absence as per British Standard Code of Practice.

1.3. **Execution of Work**

1.3.1 The Contractor should visit and examine the site of work and satisfy himself as to the nature of the existing roads and other means of communication and other details pertaining to the work and local conditions and facilities for obtaining his own information on all matters affecting the execution of work. No extra charge made in consequence of any misunderstanding, incorrect information on any of these points or on ground of insufficient description will be allowed.

1.3.2 The work shall be carried out in conformity with the fire drawings and within the

requirements of Architectural, HVAC, Electrical, Structural and Other specialized services drawings.

1.3.3 The Contractor shall cooperate with all trades and agencies working on the site. He shall make provision for hangers, sleeves, structural openings and other requirements well in advance to prevent hold up of progress of the construction schedule.

1.3.4 On award of the work, Contractor shall submit a schedule of construction in the form of a PERT Chart or BAR Chart for approval of the Project Manager/Architect/Consultant. All dates and time schedule agreed upon should be strictly adhered to, within the stipulated time of completion/commissioning along with the specified phasing, if any.

1.4 Drawings

1.4.1 Fire drawings are diagrammatic but shall be followed as closely as actual construction permits. Any deviations made shall be in conformity with the Architectural and other services drawings.

1.4.2 Architectural drawings shall take precedence over Plumbing or other services drawings as to all dimensions.

1.4.3 Contractor shall verify all dimensions at site and bring to the notice of the Project Manager all discrepancies or deviations noticed. Decision of the Project Manager shall be final.

1.4.4 Large size details and manufacturers dimensions for materials to be incorporated shall take precedence over small scale drawings.

1.4.5 All drawings issued by the Architects/Consultant for the work are the property of the Architects/Consultant and shall not be lent, reproduced or used on any works other than intended without the written permission of the Architects/Consultant.

1.5 Inspection and Testing of Materials

1.5.1 Contractor shall be required, if requested, to produce manufacturers Test Certificate for the particular batch of materials supplied to him. The tests carried out shall be as per the relevant Indian Standards.

1.5.2 For examination and testing of materials and works at the site Contractor shall provide all Testing and Gauging Equipment necessary but not limited to the followings:-

i) Theodolite, Steel tapes
j) Dumpy level
k) Weighing machine
l) Plumb bobs, Spirit levels, Hammers
m) Micrometers, Tachometers
n) Thermometers, Stoves
o) Hydraulic test machine
p) Smoke test machine

1.5.3 All such equipment shall be tested for calibration at any approved laboratory, if required by the Project Manager.

1.5.4 All Testing Equipment shall be preferably located in a special room meant for the

purpose.

1.5.5 Samples of all materials shall be got approved before placing order and the approved samples shall be deposited with the Architects or kept at site in a sample room as prepared by the owners. Any materials declared defective by Project Manager/Architect/Consultant shall be removed from the site within 48 hours.

1.6 Metric Conversion

1.6.1 All dimensions and sizes of materials and equipment given in the tender document are commercial metric sizes.

1.6.2 Any weights, or sizes given in the tender having changed due to metric conversion, the nearest equivalent sizes accepted by Indian Standards shall be acceptable without any additional cost.

1.7 Reference Points

1.7.1 Contractor shall provide permanent Bench Marks, Flag Tops and other reference points for the proper execution of work and these shall be preserved till the end of the work.

1.7.2 All such reference points shall be in relation to the levels and locations given in the Architectural and Plumbing drawings.

1.8 Reference Drawings

1.8.1 The Contractor shall maintain one set of all drawings issued to him as reference drawings. These shall not be used on site. All important drawings shall be mounted on boards and placed in racks indexed. No drawings shall be rolled.

1.8.2 All corrections, deviations and changes made on the site shall be shown on these reference drawings for final incorporation in the completion drawings. All changes to be made shall be initialed by the Project Manager or Architects.

1.9 Shop Drawings

1.9.1 The Contractor shall submit to the Project Manager three copies of the shop drawings.

1.9.2 Shop drawings shall be submitted under following conditions:-

(d) Showing any changes in layout in the plumbing drawings.

(e) Equipment layout, piping and wiring diagram.

(f) Manufacturer’s or Contractor’s fabrication drawings for any materials or equipment supplied by him.

1.9.3 The Contractor shall submit two copies of catalogues, manufacturer’s drawings, equipment characteristics data or performance charts as required by the Project Manager.

1.10 Completion Drawings

1.10.1 On completion of work, Contractor shall submit one complete set of original tracings

and two prints of “as built” drawings to the Project Manager. These drawings shall have the following information.

e) Run of all piping, diameters on all floors, vertical stacks and location of external services.

f) Ground and invert levels of all drainage pipes together with location of all manholes and connections upto outfall.

g) Run of all water supply lines with diameters, locations of control valves, access panels.

h) Location of all mechanical equipment with layout and piping connections.

No completion certificate shall be issued unless the above drawings are submitted.

1.10.2 Contractor shall provide two sets of catalogues, service manuals manufacturer’s drawings, performance data and list of spare parts together with the name and address of the manufacturer for all electrical and mechanical equipment provided by him.

1.10.3 All “Warranty Cards” given by the manufacturers shall be handed over to the Project Manager.

1.11. **Contractors Rates**

1.11.1 Rates quoted in this tender shall be inclusive of cost of materials, labour, supervision, erection, tools, plant, scaffolding, service connections, transport to site, taxes, octroi and levies, breakage, wastage and all such expenses as may be necessary and required to completely do all the items of work and put them in a working condition.

1.11.2 Rates quoted are for all heights and depths and in all positions as may be required for this work.

1.11.3 All rates quoted must be for complete items inclusive of all such accessories, Fixtures and fixing arrangements, nuts, bolts, hangers as are a standard part of the particular item except where specially mentioned otherwise.

1.11.4 All rates quoted are inclusive of cutting holes and chases in walls and floors and making good the same with cement mortar/concrete/water proofing of appropriate mix and strength as directed by Project Manager. Contractor shall provide holes, sleeves and recesses in the concrete and masonry work as the work proceeds.

1.11.5 The Contractor shall furnish the Architects with vouchers and test certificates, on request, to prove that the materials as specified and to indicate that the rates at which the materials are purchased in order to work out the rate analysis of non tendered items which he may be called upon to be carried out.

1.12 **Testing**

1.12.1 Piping works shall be tested as specified under the relevant clause(s) of the specifications.

1.12.2 Tests shall be performed in the presence of the Project Manager/ Consultant.

1.12.3 All materials and equipment found defective shall be replaced and whole work tested to meet the requirements of the specifications.

1.12.4 Contractor shall perform all such tests as may be necessary and required by the local authorities to meet Municipal or other bye-laws in force.

1.12.5 Contractor shall provide all labour, equipment and materials for the performance of the tests.

1.13 Site Clearance and Cleanup

1.13.1 The Contractor shall, from time to time clear away all debris and excess materials accumulated at the site.

1.13.2 After the Fixtures, equipment and appliances have been installed and commissioned, Contractor shall clean-up the same and remove all plaster, paints stains, stickers and other foreign matter of discoloration leaving the same in a ready to use condition.

1.13.3 On completion of all works, Contractor shall demolish all stores, remove all surplus materials and leave the site in a broom clean condition, failing which the same shall be done at Contractors risk and cost.

1.14 License Permits and Authorities

1.14.1 Contractor must keep constant liaison with the Municipal/statutory authority and obtain all approval of all drainage, water supply and other works carried out by him.

1.14.2 Contractor shall obtain, from the Municipal and other authority's necessary completion certificate(s) with respect to his work as required for occupation of the building. Contractor shall obtain permanent water supply and drainage connections from authorities concerned. Employer shall pay all fees/deposits as required to be paid to the authorities towards connection charges.

1.15 Recovery of Cost for Materials issued to Contractors Free of Cost

1.15.1 If any materials issued to the Contractor free of cost, are damaged or pilfered, the cost of the same shall be recovered from the Contractor on the basis of actual cost to owner which shall include all freight and transportation, excise duty, sales tax, octroi, import duty etc. plus 100%. The decision on the actual cost given by the Employer shall be final and binding on the Contractor.

1.16 Cutting of Water Proofing Membrane

No walls, terraces shall be cut for making and opening after water proofing has been done without written approval of Project Manager/Architects. Cutting of water proofing membrane shall be done very carefully to ensure that other portion(s) of water proofing is (are) not damaged. On completion of work at such place the water proofing membrane shall be made good and ensured that the opening/cutting is made fully water proof as per specifications and details of water proofing approved by Architects.

1.17 Cutting of Structural Members

No structural member shall be chased or cut without the written permission of the

Project Manager.

1.18. **Materials Supplied by Owner**

1.18.1 The Contractor shall verify that all materials supplied by the Employer confirm to the specifications of the relevant item in the tender. Any discrepancy found shall be brought to the notice of the Project Manager.

h) LIST OF STANDARD CODES

i)

S.No.	IS Code No.	
1.	IS:780:1984	Specification for sluice valve for water works purposes (6th rev.) (50 to 300 mm size) (amendment 3)
2.	IS:13095:1991	Butterfly valves for general purposes
3.	IS:5312 (part 1) :1984	Swing heck type reflux valves (non-return valve): part 1 single door pattern (1st rev.)(amendment 1)
4.	IS:884:1985	Fire aid hose reel for fire fighting
5.	IS:901:1988	Coupling double male and female instantaneous pattern for fire fighting
6.	IS:903:1984	Fire hose delivery coupling, branch pipe, nozzles and nozzles spanner
7.	NBC-SP-7-1983 Part IV	National building code of India 1983, amendment No. 3
8.		Central public works division (CPWD) Part-V, wet riser system for fire fighting 1985, Govt. of India
9.	IS:3844-1989	Code of practice for installation and maintenance of internal fire hydrants and hose reels on premises
10.	IS:2190:1992	Code of practice for selection and maintenance of first-aid fire extinguisher
11	IS:6382:1984	Code of practice for design and installation of fixed system carbon dioxide fire extinguishing system
12.	SP:35 (s&t)-1987	Hand book on water supply & drainage by bureau of Indian standards
13.		National Building code (sec-ix)
14.	IS:933-1989	Specifications for portable chemical from fire extinguisher
15.	IS:2171-1985	Specifications for portable fire extinguishers, dry power

SECTION – I

FIRE HYDRANT SYSTEM

1.0 Scope of work

1.1 The scope of work shall cover supply, fabrication, installation, testing and commissioning of the fire hydrant system covering the following but not limited to:

a) Fire Hydrant pumps, electric and diesel driven as shown in the equipment schedule, drawings and as required.

b) Jockey pump, electric driven as shown in the equipment schedule, drawings and as required.

c) Engine Control Panel.

d) Hydrant mains, external ring and yard hydrants.

e) Wet risers in the building as specified and shown on drawings.

f) Landing valves, hose reels, hose cabinets etc.

g) Fire brigade breaching, siamese connections and connections to pumps and appliances.

1.2 The contractor shall get the Fire Fighting System approved by the Chief Fire Officer of Local Fire Service.

2.0 Standards

2.1 The fire hydrant installation shall conform to and meet with the requirements set out by the following:

2.1.1 As relevant IS Code of practice for the safety of buildings (General) fire fighting equipment and its maintenance.

2.1.2 As relevant IS Code of practice for installation of internal fire hydrant in multi-storeyed building.

2.1.3 Compliance with the local fire brigade and the fire enforcing authorities as specifically laid down by them.

3.0 Fire pump

3.1 The fire pump shall be single stage / double stage suction centrifugal type with split casing type and direct driven by electric motor or diesel engine as specified. The pump rating and performance shall conform to the equipment schedule and meet the TAC duty requirements.

3.2 Pump casing shall be of close grained cast iron with bronze impeller. The shaft sleeve shall be brass or SS 304 and the trim shall be brass or bronze.

3.3 Pump shall be capable of delivering 150% of the rated capacity at 65% of the rated head and the no-delivery head shall be not more than 140% (150% in case of end suction type) of the rated delivery head. The pump casing shall withstand 1.5 times the no-delivery pressure or 2 times of the duty pressure whichever is higher.

3.4 The pump shall be either electrically driven or diesel driven with direct flexible

coupling.

3.5 The electric drive motor shall be squirrel cage induction conforming to IS 325 - 1978 and rated for continuous duty (S1). Motor shall have not less than class F insulation and minimum enclosure of IP22. The starter shall be air cooled fully automatic star delta or auto transformer type. Starters shall conform to IS 8544 and rated for AC-3 duty conditions.

3.6 Drive rating shall be based on the largest of the following:

a) Rated pump discharge at rated head

b) 150% of rated discharge @ 65% of rated head

c) Maximum power absorbed by the pump in its operating range i.e. no-delivery to free discharge.

The diesel engine shall be naturally aspirated (non-turbocharged) and electrically started. The engine shall be complete with starting batteries full-wave selenium rectifier charger, isolator, leads, mounting frame etc. Engine rating shall be same as for the electric motor. The detailed specifications of the engine are at Clause no 6.0.

4.0 Accessories

4.1 The Fire Pumps shall be complete with the following accessories:

a) Suction and discharge eccentric reducers

b) Pump coupling guard

c) Common base frame, fabricated mild steel or cast iron.

4.2 Each pump shall have independent set of pressure switches. The pressure switch shall be snap action SP DT switch rated 10A @ 220 V operated through a stainless steel diaphragm. The switch shall have a pointer for manual adjustment of set point, and all electrical connections shall be terminated in a screwed terminal connector. The entire unit shall be encased in a cold drawn steel (heavy gauge) enclosure. The diaphragm shall be designed for a maximum operating pressure of the system. Each pressure switch shall be provided with a pressure gauge in parallel as shown on the drawings and all gauges and pressure switches shall be mounted in an instrument panel with necessary control piping and drainage facility.

5.0 System operation and control panels

5.1 The fire pump shall be started automatically on loss of pressure and the operation sequence of the booster and fire pumps shall be as follows:

a) Jockey Pump shall start when the system pressure drops by 0.35 kg/cm2 and stop when the system pressure is re-established.

b) The Fire Pump shall start when the system pressure drops by 1.0 kg/cm2 and shall continue to run till manually switched off.

c) Jockey and fire pump starting shall be indicated on the panel with a red indication lamp.

5.2 The motor starters (direct on line or star-delta) shall consist of electrically actuated contactors. The starter shall be complete with ON-OFF push buttons, timers and auxiliary contacts and shall be fully automatic. There shall be an indicating lamp with each of the pumps and an ammeter and selector switch with the fire pumps. Fire pump starting shall be annunciated through an electric siren.

5.3 The starter along with isolator shall be housed in a 14 SWG MS box duly rust inhibited

through a process of degreasing and phosphating.

5.4 All cabling to and from the pumps to starter and control switch shall be carried out through armoured PVC cables of approved makes. Cables shall be laid in accordance with section "M V CABLING". The pump motors and panels shall be double earthed in accordance with IS 3043-1966 or as shown on drawings and as approved.

6.0 Diesel Engine

6.1 The diesel engine shall be of multi cylinder type four stroke cycle with mechanical (airless) injection, cold starting type.

6.2 The engine shall be designed with regard to ease of maintenance, repair, cleaning and inspection. This will also provide interchangeability of parts.

6.3 All parts susceptible to temperature changes shall have tolerance for expansion and contraction without resulting in leakage, misalignment of parts or injury to parts.

6.4 The engine shall be capable of both automatic and manual start. Generally the engine shall start automatically, but in case of the auto-start system failure the engine shall be capable of manual start. Engine shall be able to start without any preliminary heating of combustion chamber; cranking mechanism shall also be provided. All controls / mechanisms which have to be operated in the starting process, shall be within easy reach of the operator. A day oil tank constructed from minimum 1.6 mm thick sheet MS sheet of 200 litres capacity shall be provided as per Engine manufacturer's guide line.

6.5 A high torque D.C. motor charged by battery shall initiate automatic start of diesel engine. The battery shall hold adequate retainable charge to provide the starting of the diesel engine. Starting power will be supplied from storage batteries. The battery capacity shall be adequate for ten consecutive starts without recharging with a cold engine under full compression. Battery shall be lead acid type of 12 V, 180 Ah capacity.

6.6 The battery banks shall be used for no other purpose other than starting of the engine and shall be fully charged at all times with provision for trickle & boost chargers. After start of the engine the charger shall be disconnected, the battery being fed from the engine dynamo.

6.7 The engine shall have a speed control device (Governor) which will control the speed under all conditions of load. The governor shall be suitable for operation without external power supply.

6.8 The Engine shall an adjustable governor to regulate engine speed within a range of 10 % between shut-off and maximum load conditions of the pumps. The governor shall be set to maintain rated pump speed at maximum pump load.

6.9 The Governor shall have an over speed shutdown device to shutdown the engine at a speed approximately 20 % above rated engine speed with manual reset, so that the automatic engine controller will indicate an over speed signal until the device is manually reset to normal operating position.

6.10 The Diesel Engine shall cooled by a Heat Exchanger and the Contractor shall be make arrangement for continuous supply of such water.

6.11 The engine shall be mounts on a base plate of fabricated steel construction. Adequate access shall be provides to the big end and main bearings, camshaft and governor drives, water jackets etc.

6.12 The engine shall have a base plate made from M S sections. There shall be reasonable space at the big end, camshaft, water jackets, governor drives and main bearings.

6.13 The engine shall be provides with intake and discharge ductwork, inlet filter and silencer, outlet muffler, expansion joints, dampers etc. as necessary for efficient operation. Intake air shall be taken from inside the building in which the engine is located, but the exhaust shall be discharged into the air.

6.14 The diesel engine shall be provides with adequate instrumentation. The gauges etc. as required are provides for in the Engine Panel.

7.0 **Diesel Pump Panel:**

7.1 The Panel shall consist of the following:

7.1.1 Engine Starting System:

It shall be provided with a Lead Acid of minimum 180 Ah capacity to provide adeqaute throttle for starting.

7.1.2 Engine Instruments and Control Panel:

It shall be complete with required connections to set and comprising:

Inlet and out let water temperature gauge (dial type)

Lubrication oil pressure gauge.

Lubrication oil Temperature gauge.

Automatic Start Stop Device.

The Engine shall be provided with Manual Start / Stop Switch by means of Push Buttons.

Start Stop and Failure Control Device.

Start key for manual starting.

Stop Push Button for manual stopping of engine.

Starting failure indication by lamp and Horn Unit.

Engine temperature control with failure indication by red lamp.

Engine temperature very high indication by audio alarm and automatic stopping of engine.

Engine set in operation indication by green lamp.

Mains supply available indicated by yellow lamp.

Push Button for Audio Alarm reset.

Push Button Failure Indication by lamps.

The Panel shall also have an Auto / Manual / Test / Off Selector Switch.

8.0 Fire hydrants and hose reels

8.1 Hydrants shall be provides internally and externally as shown on the drawings. Internal hydrants shall be provides at each landing of and escape staircase and additionally depending on the floor area as shown on drawings. Landing valve shall be single headed gunmetal valve with 63 mm dia outlets and 80mm inlet conforming to IS 5290-1969. Landing valve shall have flanged inlet and instantaneous type outlets and mounted at 1.0m above the floor level. Instantaneous outlets for the hydrants shall be of standard pattern approved and suitable for 63mm dia fire brigade hoses. Wherever necessary, pressure reducing orifices plate and shall be provided so as to limit the pressure to 3.5 kg/sqcm or any other rating as required by the Local Fire Authority.

8.2 Each landing valve shall have a hose reel cabinet as shown on drawings.

a) Landing valve with single 63 mm dia outlet and 80 mm dia inlet.

b) First-aid hose reel with 30 m long 25 mm dia high pressure double braided rubber hose (IS:444 marked) with 25 m dia Ball Valve.

c) 2 Nos. 15.0 Meter long 63 mm dia Reinforced Rubber Lined (RRL) hoses with gun metal I.S. marked instantaneous couplings.

d) One gun metal branch pipe.

8.3 The First Aid Hose shall conform to IS 884-1969 and be wound on a heavy duty circular hose reel with a bracket. The hose shall be permanently connected on one end to the Wet Riser through a 25m Ball Valve with necessary hose adapter and a gun metal nozzle at the other end.

8.4 Hoses shall be in two lengths of 15.0 m each, of RRL type with instantaneous couplings, neatly rolled into bundles and held in position with steel brackets. Hoses shall be tested and certified by the manufacturer, to withstand an internal water pressure of not less than 35 kg/sqcm without bursting. The hose shall also withstand a working pressure of 7 kg/sqcm without leakage.

8.5 The hose cabinet shall be fabricated from 2mm mild steel sheet duly rust inhibited through a process of degreasing and phosphating. The cabinet shall have double flap hinged doors with 4mm clear glass and shall have necessary openings for riser main and brackets for all internals. The cabinet shall receive two coats of red oxide primer both inside and outside before two after coats of final paint of approved colour shade.

8.6 External hydrants shall be as per IS : 5490 with hand wheel control and a 80 mm dia pipe stand post. Hydrants shall be located at least 2m away from and within 15m from the building wall.

8.7 Each hydrant shall be provided with a hose cabinet containing 2x15m 63 dia RRL hoses with couplings. The cabinet shall contain a branch pipe and nozzle. The cabinet shall be 900 x 600 x 400 fabricated out of 2 m mild steel sheet duly rust inhibited through a process of degreasing, phosphating etc. The cabinet shall receive two coats of red oxide primer, inside and outside, before 2 coats of final painting of approved shade. The cabinet shall be wall-mounted or free standing with its own steel legs depending on the site conditions and as shown on drawings and as approved.

8.8 The fire brigade connection shall consist of two / three/four headed as specified in BOQ 63mm dia gun metal outlets with built-in check valve and drain plugs connected to a 150mm dia outlet connection to the water reservoir or to the hydrant main. The fire brigade collecting head shall conform to IS 904-1965.

9.0 Test & commissioning

9.1 The Jockey & fire pump starting and stopping shall be tested by opening the test valve and record the following and the valves should be as furnished below:

1) Jockey pump start/stop

System pressure at start-up : 5.0 kg/sqcm

System pressure at stop : 7.0 kg/sqcm

Time elapsed from start to stop : 2 Seconds

2) Hydrant Pump start

System pressure at start-up : 4.0 kg/sqcm

3) Diesel Engine Pump start 3.0 Kg/sqcm

9.2 Maintained system pressure while discharging the landing valve at the highest point.

a) Pump end : 7.0 kg/sqcm

b) Highest outlet : 3.5 kg/sqcm

c) Intermediate points : 5.0 kg/sqcm

10.0 Mode of measurement

Hydrant pump with mounting frame, excluding concrete foundation shall be measured per unit.

Jockey pumps same as hydrant pump.

Instrument panel with pressure gauges, pressure switches, control piping etc. shall be measured as one unit.

Control cabling from pressure gauge panel to the respective starters shall be measured in running meter and paid at unit rates.

SECTION II

PIPING FOR FIRE FIGHTING SYSTEM

1.0 Scope

1.1 The scope of work covers, supply, fabrication, laying, testing, painting and commissioning of the entire piping system for the fire fighting installation i.e. fire hydrant and sprinkler systems.

2.0 Piping

2.1 External

2.1.1 All External pipes shall be, unless otherwise specified, heavy quality mild steel tubes to IS 1239 using wrought GI steel heavy duty screwed fittings. Flanges shall be provided to mate with valves and other equipment and shall conform to IS 6392. Flanges shall be screwed type. Flanges shall be rated for 2.0 N/sqmm.

2.1.2 Black mild steel pipes, when laid underground, shall be protected against corrosion by two coats of hot bitumen and 2mm thick wrapping of pypkote. Fittings shall be weld able wrought iron, suitable for butt welding and 10% of the welded joints shall be radio graphically tested and found in order. The welded joints shall be random selected for testing in consultation with the Engineer-in-charge. All flanges shall be slip-on welded type to IS 6392 with a 3mm fibre-reinforced teflon gasket and rated for 2.0 N/sq. mm.

2.1.3 Underground mains shall be laid not less than 750 mm below the ground level and shall be at least 2m away from the building face and supported on concrete pedestals at every 3.5m and held on with galvanised iron clamps. Concrete thrust anchors shall be provided at all bends and tees as shown on drawing and as directed. All excavation for pipe laying shall be carried out with sufficient width for making proper joints. Backfilling shall be done only after the piping is hydro-statically pressure tested. Piping shall be constantly kept clean till tested.

2.1.4 All valves shall be housed in brick masonry chambers over 150mm cement concrete (1:3:6) foundation. The brick walls of the chamber shall be plastered inside and outside with 20mm cement sand plaster 1:4 with a floating coat of neat cement. Chambers shall be 650 x 650 mm clear for depths upto 1200 mm and 1000 x 1000 mm for depths beyond. Each chamber shall have a cast iron surface box approved by the Engineer in-charge.

2.1.5 Piping laid above ground shall be supported on cement concrete (1:2:4) pedestals raising the bottom of the pipe at least 150mm over the ground level and held to the pedestals with galvanised clamps. Pedestals shall be made at 3.0m centre to centre and as shown on drawings. Cement concrete 1:2:4 thrust anchors shall be provided at all tee-off points and change of direction as shown on drawings and as required. Pipes laid on walls and ceiling shall have galvanised steel brackets.

2.2 Internal

2.2.1 All internal pipes shall be, unless otherwise specified, heavy quality mild steel tubes to IS 1239 using wrought steel heavy duty screwed fittings. Flanges shall be provided to mate with valves and other equipment and shall conform to IS 6392. Flanges shall be screwed type. Flanges shall be rated for 2.0 N/sqmm.

2.2.2 Valves shall be suitable for external piping.

2.2.3 All pipes shall be of approved make and best quality without rust marks. Pipes and fittings shall be fixed in a manner as to provide easy accessibility for repair, maintenance

and shall not cause obstruction in shafts, passages etc. Pipes and fittings shall be fixed truly vertical, horizontal or in slopes as required in a neat workmanship manner. Pipes shall be securely fixed to walls and ceilings by suitable supports at intervals specified. Only approved type of anchor fasteners shall be used for RCC ceiling and walls.

2.2.4 All pipes shall be adequately supported from ceiling or walls through structural supports fabricated from mild steel structural e.g. rods, channels, angels and flats generally as shown on drawings. Fasteners shall be shear type anchor fasteners in concrete walls and ceilings and wrought steel spikes of at least 75mm long in brick walls. All pipes supports shall be painted with 1 coats of red oxide primer and two coats of black enamel paint.

2.2.5 All low point loops in the piping shall be provided with 25mm Ball Valves with rising spindle for draining the system. All valves shall have screwed brass caps. Likewise 25mm gun metal air vents shall be provided at all high point loops to prevent air-locking.

2.2.6 All piping shall have flanged joints at about 25m intervals to facilitate easy maintenance.

3.0 Pipe Jointing

3.1 All pipes shall be provided with threaded joints up to 50mm diameter and welded joints for pipe above 50mm diameters. Hold tite shall be used for sealing.

3.2 All welded joints shall be tested by radiography test.

3.3 Joints between CI and GI pipes shall be made by providing a suitable flanged tail or socket piece and MS flange on the GI pipe. Flanges shall have appropriate number of holes and shall be fastened with nuts, bolts and 1.5mm thick compressed asbestos gasket.

4.0 Valves and other accessories

4.1 Gate Valves

4.1.1 Sluice / Gate valves shall be used for isolation of flow in pipe lines For sizes upto 65 mm, gate valves shall be outside screw rising spindle type and shall be as per IS: 778 Class-I and Class-II, as applicable. For sizes 80 mm to 300 mm, gate valve shall be as per IS: 780, PN=1.0 and shall be of inside screw and non rising type and cast iron double flanged.

4.1.2 Gate valves shall be provided with a hand wheel, draining arrangement of seat valve and locking facility (as required). Gate valves shall have back setting bush to facilitate gland renewal during full open condition.

4.1.3 The Body, bonnet, Stuffing Box, cap and hand wheel shall be of cast iron to IS:210/70, grade FG 200 / 260. The non rising spindle shall be of solid forged high tensile brass or carbon steel to AISI 304 construction. The Body seating and wedge ring shall be of solid leaded gun metal. The Bonnet gasket shall be of high quality rubber.

4.1.4 The Valve shall be PN 1.0 rated but shall withstand tests of upto 20 kg / cm^2. The ends shall be flanged. The batch number of the valve shall be punched on the top of the flange. The spindle shall be removable type, and shall be easily rotated.

4.2 Pressure Switch

4.2.1 The Pressure switches shall be employed for starting and shutting down operation of pumps automatically, dictated by line pressure. The Pressure Switch shall be diaphragm type. It shall be suitable for line pressures upto 15 kg / cm2. The scale range for cut in and cut out shall be from 0 to 10 kg / cm2.

4.2.2 The Switch shall be suitable for consistent and repeated operations without change in values. It shall be provided with IP:66 water and environment protection.

4.2.3 The enclosure shall be of aluminium and pressure element and wetted parts shall be of stainless steel. The switch shall be snap acting type with 1 number N O / N C contact.

4.3 Air Vessel

4.3.1 Air vessel shall be fabricated from 6 mm thick, 300mm x 1000mm MS plate suitable for 7kg/cm^2 working pressure complete with air release valve, safety valve, pressure gauge etc. as required. The air vessel shall be continuous welded construction and

painted with two coats of Postal red enamel outside over a coat of primer and epoxy paint inside.

4.4 Pressure Vessel

4.4.1 The Pressure Vessel shall be provided to compensate for slight loss of pressure in the system and to provide an air cushion for counter acting pressure surges whenever the pumping set comes into operation. It shall be normally partly full of water, the remaining being filled with air which will be under compression when the system is in normal operation.

4.4.2 Pressure vessel shall be fabricated from 8-10 mm thick MS plate with dished ends and suitable supporting legs. It shall be provided with a 50 mm dia flanged connections from pump, one 25 mm drain with ball valve, one water level gauge and 25 mm sockets for pressure switches. The pressure vessel shall be hydraulically tested as required.

4.4.3 The Pressure Vessel shall be for Hydrant Systems. The Pressure Switches shall be mounted on the drain end of each Vessel. The Vessel shall also be provided with an air release valve mounted at the top.

4.5 Pressure Gauge

4.5.1 The Pressure Gauge shall be constructed of die cast aluminium and stove enameled. It shall be weather proof with an IP 55 enclosure. It shall be a stainless steel Bourden tube type Pressure Gauge with a scale range from 0 to 16 Kg / CM2 and shall be constructed as per IS: 3624. Each Pressure Gauge shall have a siphon tube connection. The Shut off arrangement shall be by Ball Valve.

4.6 Ball Valve

4.6.1 The Ball Valve shall be made from die cast brass and tested to 14 Kg/cm^2 pressure.

4.6.2 The valve shall be internally threaded to receive pipe connections.

4.6.3 The Ball shall be made from brass and machined to perfect round shape and subsequently chrome plated. The seat of the valve body- bonnet gasket and gland packing shall be of Teflon.

4.6.4 The handle shall be of chrome plated steel with PVC jacket. The handle shall also indicate the direction of `open' and `closed' situations. The gap between the ball and the teflon packing shall be sealed to prevent water seeping upto 14 Kg / cm^2 pressure.

4.6.5 The handle shall also be provided with a lug to keep the movement of the ball valve within 90 degree. The lever shall be operated smoothly and without application of any unnecessary force.

4.7 Non Return Valve

4.7.1 Non-return valves shall be cast iron spring action swing check type. An arrow mark in the direction of flow shall be marked on the body of the valve. The valve shall bear IS:531 certification.

4.7.2 The Valve shall be of cast iron body and cover. The internal flap in the direction of water shall be of cast iron and hinged by a hinge pin of high tensile brass or stainless steel. Cast iron parts shall be conform to IS:210 / 70, grade 200 / 260 type.

4.7.3 The gasket shall be of high quality rubber and flap seat ring of leaded gun metal to BS 1400 LG 2C. At high pressure of water flow the flapper shall seat tightly to the seat. The Valve shall be capable of handling pressure upto 15 kg / cm^2.

4.8 Butterfly Valve

4.8.1 The Butterfly Valve shall be suitable for waterworks and tested to minimum of 16 kg / sq cm pressure. The Valves shall fulfil the requirements of AWWA (American Water Works Association) C 504, API 609 and MSS-SP-67.

4.8.2 The body shall be of cast iron to IS:210 in circular shape and of high strength to take the minimum water pressure of 10 kg / cm2. The disc shall be heavy duty cast iron with anti corrosive epoxy or nickel coating.

4.8.3 The valve seat shall be of high grade elastomer or nitrile rubber. The Valve in closed position shall have complete contact between the seat and the disc throughout the perimeter. The elastomer rubber shall have a long life and shall not give away on continuous applied water pressure. The shaft shall be of EN 8 grade carbon steel.

4.8.4 The Valve shall be fitted between two flanges on either side of pipe flanges. The Valve edge rubber shall be projected outside such that they are wedged within the pipe flanges to prevent leakage.

4.8.5 The Valves shall be supplied with manual gear operated opening / closing system by lever.

5.0 Pipe supports

All pipes whether horizontal or vertical shall be suitably supported using galvanized mild steel clamps/clevis hanger manufactured by M/s Hitech Support (India) Pvt Ltd or equivalent product of good quality as approved by engineer in-charge.

5.1 Vertical Pipes

5.1.1 The pipes running vertical shaft shall be supported by galvanised mild steel rigid clamps fixed to wall with anchor bolts and studs.

5.1.2 When the horizontal distance between the centre line of two adjacent pipes is less than 300 mm a powder coated HITECH/or equivalent rail shall be fixed to wall the pipes independently clamped to the rail with `U' bolt clamps.

5.2 Horizontal Pipes

5.2.1 Pipes running horizontal shall be supported from structural beam/slab by using appropriate galvanised m.s. pipe clevis hangers.

5.2.2 The spacing of supports shall be as follows:

GI Pipes/MS Pipes		**CI Spun Pipes**	
Internal Dia (mm)	**Spacing (mm)**	**Internal dia (mm)**	**Spacing (mm)**

15	18000	75-150	27000
20, 25	24000	200-250	30000
32	27000	300	36000
40-50	30000		
65-80	36000		
100	40000		
150	45000		

5.2.3 Supports for horizontal piping longer than 15m in a stretch shall be provided with swivel clamps. Otherwise, the clamps shall be universal clamps or rigid clamps as required by the project engineer.

5.3 Fixing of clamps/rails etc.

All clamps, rails and accessories shall be fixed to the structure (beam, slab, walls etc.) by using approved good quality anchor fasteners of appropriate size.

6.0 Painting

6.1 All exposed piping for fire fighting shall be distinctly painted `Fire red' shade 536 to IS:5-1978. Pipes shall first receive two coats of red oxide primer uniformly applied and two coats of oil paint applied thereafter. All pipes supports shall be painted black as specified for support & clamps.

6.2 Painting Schedule

6.2.1 All equipment and piping shall be painted in accordance with the following colour code:

Equipment	Colour	Distinguishi

			ng Mark
a)	Pump motors	Fire Red Shade No.536 to IS: 5 -1978	
b)	Internal piping	"	
c)	Landing valves & Hose reel cabinets	"	
d)	External Hydrants	"	
e)	Fire brigade connection	"	
f)	Priming tank	"	
g)	Air vessel	"	
h)	Electric panels	Black & Red	
i)	Fire Alarm Panel	Black & Red	
j)	Repeater panel	Black & Red	
k)	Break Glass Unit	Fire Red	
l)	Hooters/Speakers	Fire Red	
m)	Sprinkler pipes	Fire Red	

6.2.2 All surfaces to be painted shall be thoroughly cleaned with wire brush to remove completely rust and other extraneous substances. Over the cleaned surfaces one coat of red oxide primer shall be applied completely covering the exposed surfaces. Finishing coat of enamel paint shall be applied one day after the prime coat, after ensuring that the paint is dry. The second coat shall be done before the installation is handed over and after approval to do so from the Engineer-in-charge.

7.0 Testing & commissioning

All piping after installation shall be tested for a hydrostatic test pressure of 10.5 kg/sqcm or 1.5 times the working pressure (whichever is less) maintained for 24 hours. All joints and valves shall be checked for leaks and rectified and retested. During testing all valves except drain & air valves shall be kept fully open.

8.0 Makes of materials

For makes of materials refer to list of approved makes of material.

9.0 Mode of measurement

9.1 All external piping shall be measured along the centre line of the pipe and paid per unit

length and shall include:

9.1.1 All pipes & fittings

9.1.2 Bituminous coating

9.2 All internal piping shall be measured similarly but shall include for the pipe supports and clamps.

9.3 All valves, air valves, drain valves together with flanges or tail pieces shall be measured per unit.

9.4 All excavation and concrete supports and thrust blocks shall be measured as per drawing and paid for per cum.

9.5 The cost of pipe supports described above form part of the rate quoted for piping and no extra shall be payable on the account.

All painting shall form part of the cost of equipment piping etc. No separate payment shall be admissible.

SECTION - III
SPRINKLER SYSTEM

1.0 **Pendant type Sprinkler Head**

1.1 Sprinkler heads shall be of quartzoid bulb type with bulb, valve assembly, yoke and the deflector. The sprinkler shall be of approved make and type with 15 mm nominal dia outlets.

1.2 The bulb shall be made of corrosion free material strong enough to withstand any water pressure likely to occur in the system. The bulb shall shatter when the temperature of the surrounding air reaches at 68^{o} C / 79^{o} C.

1.3 The nominal bore shall be 15 mm dia and colour of liquid shall be Red / Yellow.

1.4 The Sprinkler head shall be approved by UL / FM.

2.0 Upright type Sprinkler Head

2.1 Upright sprinkler heads shall be similar to Pendent type in material construction and performance but designed to throw water Droplets upwards in umbrella fashion, to cool the underside of ceiling and extinguish any fire involving combustibles on the floor below.

2.2 The Sprinkler head shall be approved by UL / FM. The nominal bore shall be 15 mm dia and the colour of liquid shall be red.

2.3 Upright Sprinkler heads shall be use in lower and upper basement parking areas and above the false ceiling.

3.0 Side Wall type Sprinkler Head

3.1 Side wall sprinkler heads shall be similar to Pendent type in material construction and performance but designed to throw water Droplets horizontally.

3.2 The Sprinkler head shall be approved by UL / FM. The nominal bore shall be 15 mm diameter and the colour of liquid shall be red.

3.3 Side wall sprinkler heads shall be use in staircase landing and along the ramp.

4.0 Powder coated Sprinkler with Powder coated Twin plate Rosette.

4.1 Most areas below false ceiling shall be provided with powder coated pendant sprinkler with twin plate sliding rosette. The sprinkler head shall be same as Pendent type above but powder coated white. The sprinkler head shall be provided with a double plate powder coated rosette that shall seal the gap between the false ceiling and he sprinkler head.

4.2 The adjustment allowable shall be 12 mm. The lower part shall have flared ends that shall fit tightly into the upper piece.

4.3 The Sprinkler head shall be approved by UL / FM. The nominal bore shall be 15 mm diameter and the colour of liquid shall be red.

5.0 **Installation Control Valve for Sprinkler**

4.1 The Installation Control Valve shall be double seated clapper type check valve. The Body and cover shall be made from Cast Iron to IS:210 Grade FG 200. The seat and seat clamp shall be made from bronze to IS: 318, LTB II grade. The sealing to the seat shall be neoprene gasket. The hinges pin and ball shall be from stainless steel.

4.2 It shall be vertically mounted and the direction of water travel shall be indicated on the surface. It shall be rated to 12 Kg / cm^2 and tested to 25 Kg / cm^2 pressure.

4.3 A By-pass check valve shall be fitted to adjust minor and slow variations in water pressure for balancing so as to avoid any false alarm.

4.4 The valve shall also be provided with a Test Control Box. The Box shall house a lever to test and operate the ICV. A brass strainer shall also be provided at the point of water supply to the Alarm gong. A Retarding Chamber shall also be provided.

4.5 The Chamber shall be able to balance the water pressure in case of water line surges.

4.6 Each Installation Control Valve shall have two sets of Pressure Gauges with brass ball valve type shut off.

4.7 A Water Motor Alarm. shall also be provided. This shall be mechanically operated by discharge of water through an impeller. The drive bearing shall be weather resistant. A strainer shall be provided on line before the nozzle. The Gong piece shall be constructed from bronze to IS 318, 2 TB II Grade, and base of cast iron. The Motor Housing, Rotor and Housing Cover shall be pressure die cast aluminium.

6.0 Flow Switch

6.1 Flow switch shall have a paddle made of flexible material of the width to fit within the pipe bore. The terminal box shall be mounted over the paddle / pipe through a connecting socket. The Switch shall be potential free in either N O or N C position as required. The switch shall be able to trip and make / break contact on the operation of a single sprinkler head. The terminal box shall have connections for wiring to the Annunciation Panel. The seat shall be of stainless steel. The Flow Switch shall have IP:55 protection.

6.2 The Flow Switch shall work at a minimum flow rate of 100 LPM. Further, it shall have a 'Retard' to compensate for line leakage or intermittent flows.

7.0 Makes of materials

For makes of materials refer to list of approved makes of material.

8.0 Mode of measurement

8.1 Sprinkler head including supports and clamps for fixing shall be measured as unit.

8.2 All alarm control valves including drain valves, butterfly valve and all other accessories together with flanges or tail pieces shall be measured per unit.

8.3 All floor control valves including drain valves, butterfly valve, sight glass and all other accessories together with flanges or tail pieces shall be measured per unit.

SECTION - IV

PORTABLE FIRE EXTINGUISHERS & EXIT SIGNAGES

1.0 Scope

1.1 The scope of work covers the supply and installation of portable fire extinguishers. The following types are envisaged in these specifications and provided as shown in the schedule of portable fire extinguishers.

1.0.1 Dry powder extinguisher
1.0.2 Carbon-dioxide extinguisher
1.0.3 Mono ammonia phosphate extinguisher
1.0.4 Water expelling type.

2.0 Standards

2.1 The following standards and rules and regulations shall be applicable:

2.1.1 Fire protection manual of the tariff advisory committee, Fire Insurance Association of India

2.1.2 IS:2176 :Portable fire extinguisher Dry power type

2.1.3 IS:2878 :Portable fire extinguisher carbon-dioxide type

2.1.4 Local Fire Brigade/Authority

2.2 All standards mean the latest.

3.0 Fire Extinguishers

TECHNICAL SPECIFICATION

The following specifications required for Portable Fire Extinguisher as per IS: 15683/IS: 2190 and for Trolley Mounted Fire Extinguishers as per IS 16018. The details are as under:

3.1 DRY CHEMICAL POWDER (DCP) - ABC SQUEEZE GRIP CARTRIDGE TYPE PORTABLE FIRE EXTINGUISHERS:

i **These Extinguishers should contain Mono-ammonium Phosphate based dry powder as per IS: 15683:2018 and capable of fire-fighting class A, B and C Fires. Propellant in cartridge operated extinguishers shall be carbon dioxide gas cartridge. The method of expulsion of dry power shall be by means of pressure produced from compressed or liquefied gas from gas cartridge attached to the cap after piercing it uprightly or by piercing the squeeze grip.**

a) PERFORMANCE & CONSTRUCTION REQUIREMENT:

PERFORMANCE	CAPACITY – 04 KG	CAPACITY – 06 KG
Approvals/certification	IS:15683, ISI Marked & CE	IS:15683, ISI Marked & CE

Suitable for class of Fire	Class: A, B, C	Class: A, B, C
Fire Rating	3A, 55B	4A, 89B
Working/Operating Temperature (Ċ)	-30 to +55	-30 to +55
Burst Pressure	55 Kg/cm^2	55 Kg/cm^2
Service/Max. Service /Test Pressure	15/18/35 bar	15/18/35 bar
Minimum Effective Discharge Time	13-25 Seconds	15-25 Seconds
Bulk Range % Discharge	2 to 4 meter, 95%	3 to 6 meter, 95%
Propellant	Carbon Dioxide Gas, 100-120 gm	Carbon Dioxide Gas, 100-120 gm
Thickness (Approx.)	1.6 mm	1.6 mm
Height Without Base (Approx.)	510 mm	540 mm
Diameter (Approx.)	140 (+/-10) mm	150 (+/-10) mm
Gross Weight (Approx.)	8 kg	10 kg
Extinguishing Agent Charge	Mono-ammonium Phosphate based dry powder	Mono-ammonium Phosphate based dry powder

These cartridge operated extinguishers the cartridge shall be pierced, and the pressure allowed to build for 06 second before opening the control valve.

CONSTRUCTION: The cylinder body, expansion space, neck ring, cap, gas cartridge and cartridge holder, plunger rod and piercing mechanism, cap joint washer, hose. Nozzle and bottom ring shall be confirmed as per Indian Specification (IS: 15683).

b) MANUFACTURING TESTS: The Extinguishers shall comply all manufacturing tests specified in the IS: 15683, like leakage test, burst strength test, impact resistance test, hose assemblies test, safety locking device etc.

c) COLOUR: The colour for extinguisher bodies shall be in fire red colour confirming to IS: 05 and paint shall confirm to IS: 2932.

d) MARKING:

i The operating, recharging and inspection and maintenance instructions shall be in the form of an etched or embossed metal nameplate or band, or an acceptable pressure-sensitive nameplate attached to the side of the extinguisher body, or in the form of silk-screening of paint directly on the extinguisher body. The marking shall identify the extinguisher as to type of media and shall include the manufacturer's name and model number and the rating and classification of the fire extinguisher.

ii The marking shall include a sequential serial number.

iii The year of manufacture, or the last two digits of the calendar year, and the factory test pressure shall permanently marked into the extinguisher body or non-transferable nameplate. Extinguishers manufactured in the first three months of a calendar year may be marked with the previous year as the date of manufacturer.

iv The marking shall include a reference to the range of temperatures at which the extinguisher is usable, such as acceptable to use at temperature from….. to ….. or the equivalent.

v The applicable statement or the equivalent shall be included in the marking: Recharge immediately after any use. The gas cartridge shall be permanently marked with:

a. Empty mass in gram,
b. Nominal full mass in gram,
c. Year of manufacturer, and
d. Name or code of the manufacturer.

vii. The marking on each extinguisher shall include its exact gross mass or minimum and maximum gross mass, which may be expressed by a tolerance. The gross mass shall include the mass of the charged extinguisher and discharge assembly.

viii. The Extinguisher shall be marked with BIS standard. The use of standard mark will be governed by the provisions of the BIS Act 1986.

ix. Operating instructions: the operating instructions shall be arranged as follows:

a) Word “INSTRUCTIONS” shall be at the top of the nameplate.
b) Operating instructions shall be in the form of numerically sequenced photograph. The sequence shall be as follows:
   - ✓ Making ready the extinguisher by disengaging the safety locking device,
   - ✓ Aiming the extinguisher at the base of fire, included recommended distance from the fire at which to begin discharge, and indicating the intended operating attitude of the extinguisher,
   - ✓ Taking whatever action necessary to initiate operation of the extinguishers, and
   - ✓ Describing the intended method of applying the extinguishing media on the fire.

x. The extinguisher shall be marked with letters “A”, “B”, and “C” indicating their suitability for respective class of fires.

3.2 DRY CHEMICAL POWDER (DCP) - ABC STORED PRESSURE TYPE PORTABLE FIRE EXTINGUISHERS:

These Extinguishers should contain Mono-ammonium Phosphate based dry powder as per IS: 15683:2018 and capable of fire-fighting class A, B and C Fires. The method of expulsion of the extinguishing media shall be by pressing the squeeze grip of the assembly valve assembly.

a) <u>PERFORMANCE & CONSTRUCTION REQUIREMENT:</u>

PERFORMANCE	**CAPACITY - 02KG**	**CAPACITY - 04KG**	**CAPACITY - 06KG**
Approvals/certification	IS:15683, ISI Marked & CE	IS:15683, ISI Marked & CE	IS:15683, ISI Marked & CE
Suitable for class of Fire	Class: A, B, C	Class: A, B, C	Class: A, B, C
Expelling agent	Nitrogen (UHP Grade)	Nitrogen (UHP Grade)	Nitrogen (UHP Grade)
Fire Rating	2A, 34B	3A, 55B	4A, 89B

Working/Operating Temperature (Ċ)	-30 to +55	-30 to +55	-30 to +55
Burst Pressure	55 Kg/cm^2	55 Kg/cm^2	55 Kg/cm^2
Service/Max. Service /Test Pressure	15/18/35 bar	15/18/35 bar	15/18/35 bar
Minimum Effective Discharge Time (approx.)	14 sec	18 sec	24 sec
Average range of throw	2 meter	3 meter	5 meter
Average discgarge	95%	95%	95%
Thickness (Approx.)	1.6 mm	1.6 mm	1.6 mm
Height (Approx.)	380 mm	490 mm	530 mm
Diameter (Approx.)	106 ± 10 mm	140 ± 10 mm	150 ± 10 mm
Empty weight (approx.)	1.4 kg	2.6 kg	2.9 kg
Full weight (Approx.)	3.4 kg	6.6 kg	8.9 kg
Extinguishing Agent Charge	Mono-ammonium Phosphate based dry powder	Mono-ammonium Phosphate based dry powder	Mono-ammonium Phosphate based dry powder

CONSTRUCTION: The cylinder body, expansion space, neck ring, cap, cap joint washer, hose. Nozzle and bottom ring shall be confirmed as per Indian Specification (IS: 15683).

b) MANUFACTURING TESTS: The Extinguishers shall comply all manufacturing tests specified in the IS: 15683, like leakage test, burst strength test, impact resistance test, hose assemblies test, safety locking device etc.

c) COLOUR: The colour for extinguisher bodies shall be in fire red colour confirming to IS: 05 and paint shall confirm to IS: 2932.

d) MARKING:

i The operating, recharging and inspection and maintenance instructions shall be in the form of an etched or embossed metal nameplate or band, or an acceptable pressure-sensitive nameplate attached to the side of the extinguisher body, or in the form of silk-screening of paint directly on the extinguisher body. The marking shall identify the extinguisher as to type of media and shall include the manufacturer's name and model number and the rating and classification of the fire extinguisher.

ii The marking shall include a sequential serial number.

iii The year of manufacture, or the last two digits of the calendar year, and the factory test pressure shall permanently marked into the extinguisher body or non-transferable

nameplate. Extinguishers manufactured in the first three months of a calendar year may be marked with the previous year as the date of manufacturer.

iv The marking shall include a reference to the range of temperatures at which the extinguisher is usable, such as acceptable to use at temperature from….. to ….. or the equivalent.

v The marking on each extinguisher shall include its exact gross mass or minimum and maximum gross mass, which may be expressed by a tolerance. The gross mass shall include the mass of the charged extinguisher and discharge assembly.

vi The Extinguisher shall be marked with BIS standard. The use of standard mark will be governed by the provisions of the BIS Act 1986.

vii Operating instructions: the operating instructions shall be arranged as follows:

a) Word "INSTRUCTIONS" shall be at the top of the nameplate.

b) Operating instructions shall be in the form of numerically sequenced photograph. The sequence shall be as follows:

- ✓ Making ready the extinguisher by disengaging the safety locking device,
- ✓ Aiming the extinguisher at the base of fire, included recommended distance from the fire at which to begin discharge, and indicating the intended operating attitude of the extinguisher,
- ✓ Taking whatever action necessary to initiate operation of the extinguishers, and
- ✓ Describing the intended method of applying the extinguishing media on the fire.

viii. The extinguisher shall be marked with letters "A", "B", and "C" indicating their suitability for respective class of fires.

3.3 CARBON DIOXIDE (CO2) GAS TYPE FIRE EXTINGUISHERS:

a) These Extinguishers shall be based on CO2 gas. The Carbon Dioxide (CO_2) gas shall confirm to IS: 15222. The quantity shall be determined by weighing. The filling ratio is the ratio of mass of liquefiable gas that is allowed to be filled into the container in view of safety considerations to the mass of water required to fill the container at 15 degrees centigrade. It is operated by holding upright, removing the locking pin or seal or safety device from the **wheel type control valve operating mechanism**.

b) The Extinguisher is made from **seamless** manganese steel cylinders confirming to IS: 7285 with ISI Marked & **approved from Chief Controller of Explosives (CCE).** Valve confirming to IS: 3224 with ISI Mark.

c) The extinguisher discharge horn shall be constructed to withstand crushing when 25 kg applied to its extremity for 5 min immediately after having completely discharged the extinguisher through the horn. Check that the horn does not show any evidence of cracking or breakage.

d) <u>PERFORMANCE & CONSTRUCTION REQUIREMENT:</u>

PERFORMANCE	**CAPACITY – 3 kg**	**CAPACITY - 4.5 kg**	**CAPACITY - 22.5 kg**
Approvals/certification	IS:15683, ISI Marked, CE & PESO	IS:15683, ISI Marked**,** CE & PESO	IS: 2878, ISI Marked, CE & PESO
Fire Rating	21 B	55 B	89 B

Working / Operating Temperature (Degree Centigrade)	-30 to +55	-30 to +55	-30 to +55
Burst Pressure (Approx.)	335-350 bar	335-350 bar	335-350 bar
Cylinder Testing Pressure	250 bar	250 bar	250 bar
Minimum Effective Discharge Time	08-15 Second	08-17 Second	20-60 Second
Range (approx.) , Discharge	2 meter, 95%	2 meter, 95%	2 meter, 95%
Thickness (Approx.)	4.2 mm	4.2 mm	5.5 mm
Height (Approx.)	435-545mm	610-700 mm	1030 mm
Diameter (Approx.)	140 (+/- 10) mm	140 (+/- 10) mm	232 (+/- 10) mm
Gross Weight (Approx.)	12.5 kg	17 kg	84 kg
Extinguishing Agent Charge	CO_2 Gas	CO_2 Gas	CO_2 Gas

CONSTRUCTION: The cylinder body, discharge fittings, trolley, valve, (i.e. Nozzle, Hose, etc) shall be confirmed as per Indian Specification IS: 15683 & IS: 2878.

e) PAINTING:

- Each Extinguisher shall be painted fire red confirming to shade No. 536 or 537of IS: 5.
- A picture showing a man operating the extinguisher in the correct manner shall be shown on the body of the extinguisher.
- The extinguisher shall be marked with the letters B, & C indicating their suitability for respective classes of fires as laid down in IS: 2190:1992.

f) MARKING: Each extinguisher shall be clearly and permanently marked with the following information:

- Manufacturer's name or trade – mark, serial No., and year of manufacture shall be **EMBOSSED** at the bottom ring/body/neck.
- Method of operation in prominent letter. The words "Carbon Dioxide Type" "class BC Capacity of the extinguisher in kg.
- Year of manufacturer of extinguisher and date of refilling.
- Source, Year of manufacture of the cylinder and its test pressure.
- The product shall be marked with BIS Standard Mark.

The following information to facilitate filling or recharging shall also be marked on the head of extinguisher or on the neck of the cylinder:

- the weight of extinguisher (to include operating head, Internal discharge tube and carrying handle but not any hose or discharge horn assembly) shown as EW.
- Filled weight of extinguisher (to include operating head, internal discharge tube, carrying handle and gas filled contents but not any hose or discharge horn assembly) shown as FW.

3.4 **WATER CO2 SQUEEZE GRIP CARTRIDGE TYPE PORTABLE FIRE EXTINGUISHERS:**

These Extinguishers shall water as per IS: 15683 and **capable of firefighting class A** Fire. Propellant in cartridge operated extinguishers shall be carbon dioxide gas cartridge. The method of expulsion of water shall be by means of pressure produced from compressed or liquefied gas from gas cartridge attached to the cap after piercing it uprightly or by piercing the squeeze grip.

a) PERFORMANCE & CONSTRUCTION REQUIREMENT:

PERFORMANCE	**CAPACITY - 9 Liter**
Approvals/certification	IS:15683, ISI Marked
Fire Rating	2A
Working/Operating Temperature (Ċ)	+05 to +55
Burst Pressure	55/80 bar (min)
Cylinder Testing Pressure	35 bar
Service / Working Pressure (Approx.)	14-15bar
Minimum Effective Discharge Time	13-42 Second
Bulk Range % Discharge	02-07 meter, 85%
Propellant	Carbon Dioxide Gas Cartridge
Thickness (Approx.)	1.6 mm
Height (Approx.)	570-585 mm
Diameter (Approx.)	175-180 (+/- 10) mm
Gross Weight (Approx.)	12-15kg
Extinguishing Agent Charge	Water

These cartridge operated extinguishers the cartridge shall be pierced and the pressure allowed to
build for 06 second before opening the control valve.

CONSTRUCTION: The cylinder body, expansion space, neck ring, cap, gas cartridge and cartridge holder, plunger rod and piercing mechanism, cap joint washer, hose. Nozzle and bottom ring shall be confirmed as per Indian Specification (IS:15683).

b) MANUFACTURING TESTS: The Extinguishers shall fulfill all manufacturing tests specified in the IS: 15683, like leakage test, burst strength test, impact resistance test, hose assemblies test, safety locking device etc.

c) COLOUR: The colour for extinguisher bodies shall be in fire red colour confirming to IS: 05 and paint shall confirm to IS: 2932.

d) MARKING:

i The operating, recharging and inspection and maintenance instructions shall be in the form of an etched or embossed metal nameplate or band, or an acceptable pressure-sensitive nameplate attached to the side of the extinguisher body, or in the form of silk-screening of paint directly on the extinguisher body. The marking shall identify the extinguisher as to type of media and shall include the manufacturer's name and model number and the rating and classification of the fire extinguisher.

ii The marking shall include a sequential serial number.

iii The year of manufacture, or the last two digits of the calendar year, and the factory test pressure shall permanently marked into the extinguisher body or non-transferable nameplate. Extinguishers manufactured in the first three months of a calendar year may be marked with the previous year as the date of manufacturer.

iv The marking shall include a reference to the range of temperatures at which the extinguisher is usable, such as acceptable to use at temperature from…..
to ….. or the equivalent.

v The applicable statement or the equivalent shall be included in the marking:
Recharge immediately after any use.

vi The gas cartridge shall be permanently marked with:

i. Empty mass in gram,
ii. Nominal full mass in gram,
iii. Year of manufacturer, and
iv. Name or code of the manufacturer.

vii The marking on each extinguisher shall include its exact gross mass or minimum and maximum gross mass, which may be expressed by a tolerance. The gross mass shall include the mass of the charged extinguisher and discharge assembly.

viii The Extinguisher shall be marked with BIS standard. The use of standard mark will be governed by the provisions of the BIS Act 1986.

ix Operating instructions: the operating instructions shall be arranged as follows:

i. Word "INSTRUCTIONS" shall be at the top of the nameplate.
ii. Operating instructions shall be in the form of numerically sequenced photograph. The sequence shall be as follows:
   - ✓ Making ready the extinguisher by disengaging the safety locking device,
   - ✓ Aiming the extinguisher at the base of fire, included recommended distance from the fire at which to begin discharge, and indicating the intended operating attitude of the extinguisher,
   - ✓ Taking whatever action necessary to initiate operation of the extinguishers, and
   - ✓ Describing the intended method of applying the extinguishing media on the fire.

x) The extinguisher shall be marked with letters "A" indicating their suitability for respective class of fires.

3.5 WATER SQUEEZE GRIP STORED PRESSURE TYPE PORTABLE FIRE EXTINGUISHERS:

These Extinguishers is suitable for Class "A' Fire such as wood, furnishings, cloth, stationery etc. as per IS: 15683:2018. The method of expulsion of the extinguishing media shall be by pressing the squeeze grip of the assembly valve assembly.

a) <u>PERFORMANCE & CONSTRUCTION REQUIREMENT:</u>

PERFORMANCE	CAPACITY – 9 Liters
Approvals/certification	IS:15683, ISI Marked & CE
Suitable for class of Fire	Class: A
Expelling agent	Nitrogen (UHP Grade)
Fire Rating	3A
Working/Operating Temperature (Ċ)	-30 to +55
Burst Pressure	55 Kg/cm^2
Service/Max. Service /Test Pressure	15/18/35 bar
Discharge Time (approx.)	35 sec
Average range of throw	5-6 meter
Average discgarge	95%
Thickness (Approx.)	1.6 mm
Height (Approx.)	575 mm
Diameter (Approx.)	180 ± 10 mm
Empty weight (approx.)	4.9 kg
Full weight (Approx.)	13.9 kg
Extinguishing Agent Charge	Water

CONSTRUCTION: The cylinder body, expansion space, neck ring, cap, cap joint washer, hose. Nozzle and bottom ring shall be confirmed as per Indian Specification (IS: 15683).

b) MANUFACTURING TESTS: The Extinguishers shall comply all manufacturing tests specified in the IS: 15683, like leakage test, burst strength test, impact resistance test, hose assemblies test, safety locking device etc.

c) COLOUR: The colour for extinguisher bodies shall be in fire red colour confirming to IS: 05 and paint shall confirm to IS: 2932.

d) MARKING:

i The operating, recharging and inspection and maintenance instructions shall be in the form of an etched or embossed metal nameplate or band, or an acceptable pressure-sensitive nameplate attached to the side of the extinguisher body, or in the form of silk-screening of paint directly on the extinguisher body. The marking shall identify the extinguisher as to type of media and shall include the manufacturer's name and model number and the rating and classification of the fire extinguisher.

ii The marking shall include a sequential serial number.

iii The year of manufacture, or the last two digits of the calendar year, and the factory test pressure shall permanently marked into the extinguisher body or non-transferable nameplate. Extinguishers manufactured in the first three months of a calendar year may be marked with the previous year as the date of manufacturer.

iv The marking shall include a reference to the range of temperatures at which the extinguisher is usable, such as acceptable to use at temperature from….. to ….. or the equivalent.

v The marking on each extinguisher shall include its exact gross mass or minimum and maximum gross mass, which may be expressed by a tolerance. The gross mass shall include the mass of the charged extinguisher and discharge assembly.

vi The Extinguisher shall be marked with BIS standard. The use of standard mark will be governed by the provisions of the BIS Act 1986.

vii Operating instructions: the operating instructions shall be arranged as follows:

c) Word "INSTRUCTIONS" shall be at the top of the nameplate.

d) Operating instructions shall be in the form of numerically sequenced photograph. The sequence shall be as follows:

- ✓ Making ready the extinguisher by disengaging the safety locking device,
- ✓ Aiming the extinguisher at the base of fire, included recommended distance from the fire at which to begin discharge, and indicating the intended operating attitude of the extinguisher,
- ✓ Taking whatever action necessary to initiate operation of the extinguishers, and
- ✓ Describing the intended method of applying the extinguishing media on the fire.

ix. The extinguisher shall be marked with letters "A" indicating their suitability for respective class of fires.

3.6 TECHNICAL SPECIFICATIONS OF ABC TYPE MODULAR TYPE SELF EXTINGUISHING FIRE EXTINGUISHER, CAP-5KG

The following important features should be:

i. An automatic detection and suppression system together in a single unit and should be reusable cylinder.

ii. The system should provide automatic round the clock protection and non-freezing.

iii. The system should be Rechargeable and easy to service.

The following performance required as data given as under:

i. Propellant should be used as Nitrogen Gas.
ii. Working pressure should be 7 to 15 kgs/cm2.
iii. Testing pressure should be 35 kgs/cm2.
iv. Area of protection should be 3.5 to 4.0 meter square and volume protection should be 8.0 m3
v. Feasible to hang vertically above risk is 1.5 to 2.0 meter.
vi. Operation time should be 99% in 10-15 seconds.
vii. Extinguishing media should be used ABC (mono ammonium phosphate-90) powder.
viii. The cylinder should be MIG welded M.S. Body 2mm CRC Sheet upper part of which is fitted with adapter or flange for fixing on ceiling wall and below part fixed automatic release Nozzle based on Sprinkler technology unlike the sprinkler nozzle is gas tight the release temperature is adjusted with sprinkler bulb as 57 to 68 degree centigrade with pressure gauge fitted for instant verification of reliability of every unit.
ix. Nozzle should give more than 95% discharge and scattering cone on 40 to 45 degree angle.

3.7 TROLLEY MOUNTED WATER TYPE FIRE EXTINGUISHERS (CARTRIDGE TYPE):

a) PERFORMANCE & CONSTRUCTION REQUIREMENT:

PERFORMANCE	**CAPACITY – 45 Liter**

Approvals/certification	IS:16018, ISI Marked & CE
Fire Rating	20A
Working/Operating Temperature (Ċ)	+05 to +55
Burst pressure	55 bar
Service/Max. Service /Test Pressure	15/18/35 bar
Discharge Time (minimum)	30 Seconds
Range of throw (minimum)	9 meters
Propellant	Carbon Dioxide Gas Cartridge
Cartridge	300 gm inner cartridge
Thickness (Approx.)	1.6 mm
Height (Approx.)	1000 mm
Diameter (Approx.)	300 (+/- 10) mm
Gross Weight (Approx.)	85 kg
Extinguishing Agent Charge	Water

These cartridge operated extinguishers the cartridge shall be pierced and the pressure allowed to
build for 06 second before opening the control valve.

CONSTRUCTION: The cylinder body, expansion space, neck ring, cap, gas cartridge and cartridge holder, plunger rod and piercing mechanism, cap joint washer, hose. Nozzle and bottom ring shall be confirmed as per Indian Specification (IS:15683).

b) MANUFACTURING TESTS: The Extinguishers shall fulfill all manufacturing tests specified in the IS: 15683, like leakage test, burst strength test, impact resistance test, hose assemblies test, safety locking device etc.

c) COLOUR: The colour for extinguisher bodies shall be in fire red colour confirming to IS: 05 and paint shall confirm to IS: 2932.

d) MARKING:

i. The operating, recharging and inspection and maintenance instructions shall be in the form of an etched or embossed metal nameplate or band, or an acceptable pressure-sensitive nameplate attached to the side of the extinguisher body, or in the form of silk-screening of paint directly on the extinguisher body. The marking shall identify the extinguisher as to type of media and shall include the manufacturer's name and model number and the rating and classification of the fire extinguisher.

ii. The marking shall include a sequential serial number.

iii. The year of manufacture, or the last two digits of the calendar year, and the factory test pressure shall permanently marked into the extinguisher body or non-transferable nameplate. Extinguishers manufactured in the first three months of a calendar year may be marked with the previous year as the date of manufacturer.

iv. The marking shall include a reference to the range of temperatures at which the extinguisher is usable, such as acceptable to use at temperature from…..
to ….. or the equivalent.

v. The applicable statement or the equivalent shall be included in the marking:
Recharge immediately after any use.

vi. The gas cartridge shall be permanently marked with:
   i. Empty mass in gram,
   ii. Nominal full mass in gram,
   iii. Year of manufacturer, and
   iv. Name or code of the manufacturer.

vii. The marking on each extinguisher shall include its exact gross mass or minimum and maximum gross mass, which may be expressed by a tolerance. The gross mass shall include the mass of the charged extinguisher and discharge assembly.

viii. The Extinguisher shall be marked with BIS standard. The use of standard mark will be governed by the provisions of the BIS Act 1986.

ix. Operating instructions: the operating instructions shall be arranged as follows:
   i. Word "INSTRUCTIONS" shall be at the top of the nameplate.
   ii. Operating instructions shall be in the form of numerically sequenced photograph. The sequence shall be as follows:
      ✓ Making ready the extinguisher by disengaging the safety locking device,
      ✓ Aiming the extinguisher at the base of fire, included recommended distance from the fire at which to begin discharge, and indicating the intended operating attitude of the extinguisher,
      ✓ Taking whatever action necessary to initiate operation of the extinguishers, and
      ✓ Describing the intended method of applying the extinguishing media on the fire.

x) The extinguisher shall be marked with letters "A" indicating their suitability for respective class of fires.

3.8 TROLLEY MOUNTED DRY CHEMICAL TYPE FIRE EXTINGUISHERS (CARTRIDGE TYPE):

a) PERFORMANCE & CONSTRUCTION REQUIREMENT:

PERFORMANCE	**CAPACITY – 25 kg**
Approvals/certification	IS:16018, ISI Marked & CE
Fire Rating	20A, 233B
Working/Operating Temperature (Ċ)	+05 to +55
Burst pressure	55 bar
Service/Max. Service /Test Pressure	15/18/35 bar
Discharge Time (minimum)	30 Seconds
Range of throw (minimum)	6 meters
Propellant	Carbon Dioxide Gas Cartridge
Cartridge	Inner cartridge or 1 kg outer cartridge
Thickness (Approx.)	1.6 mm
Height (Approx.)	980 mm
Diameter (Approx.)	300 (+/- 10) mm
Gross Weight (Approx.)	84 kg

Extinguishing Agent Charge	Mono-ammonium Phosphate based dry chemical powder

These cartridge operated extinguishers the cartridge shall be pierced and the pressure allowed to
build for 06 second before opening the control valve.

CONSTRUCTION: The cylinder body, expansion space, neck ring, cap, gas cartridge and cartridge holder, plunger rod and piercing mechanism, cap joint washer, hose. Nozzle and bottom ring shall be confirmed as per Indian Specification (IS:15683).

b) MANUFACTURING TESTS: The Extinguishers shall fulfill all manufacturing tests specified in the IS: 15683, like leakage test, burst strength test, impact resistance test, hose assemblies test, safety locking device etc.

c) COLOUR: The colour for extinguisher bodies shall be in fire red colour confirming to IS: 05 and paint shall confirm to IS: 2932.

d) MARKING:

i. The operating, recharging and inspection and maintenance instructions shall be in the form of an etched or embossed metal nameplate or band, or an acceptable pressure-sensitive nameplate attached to the side of the extinguisher body, or in the form of silk-screening of paint directly on the extinguisher body. The marking shall identify the extinguisher as to type of media and shall include the manufacturer's name and model number and the rating and classification of the fire extinguisher.

ii. The marking shall include a sequential serial number.

iii. The year of manufacture, or the last two digits of the calendar year, and the factory test pressure shall permanently marked into the extinguisher body or non-transferable nameplate. Extinguishers manufactured in the first three months of a calendar year may be marked with the previous year as the date of manufacturer.

iv. The marking shall include a reference to the range of temperatures at which the extinguisher is usable, such as acceptable to use at temperature from…..
to ….. or the equivalent.

v. The applicable statement or the equivalent shall be included in the marking:
Recharge immediately after any use.

vi. The gas cartridge shall be permanently marked with:
    i. Empty mass in gram,
    ii. Nominal full mass in gram,
    iii. Year of manufacturer, and
    iv. Name or code of the manufacturer.

vii. The marking on each extinguisher shall include its exact gross mass or minimum and maximum gross mass, which may be expressed by a tolerance. The gross mass shall include the mass of the charged extinguisher and discharge assembly.

viii. The Extinguisher shall be marked with BIS standard. The use of standard mark will be governed by the provisions of the BIS Act 1986.

ix. Operating instructions: the operating instructions shall be arranged as follows:
    i. Word "INSTRUCTIONS" shall be at the top of the nameplate.
    ii. Operating instructions shall be in the form of numerically sequenced photograph. The sequence shall be as follows:
        - ✓ Making ready the extinguisher by disengaging the safety locking device,
        - ✓ Aiming the extinguisher at the base of fire, included recommended distance from the fire at which to begin discharge, and indicating the intended operating attitude of the extinguisher,
        - ✓ Taking whatever action necessary to initiate operation of the extinguishers, and

- ✓ Describing the intended method of applying the extinguishing media on the fire.

x) The extinguisher shall be marked with letters “A”, “B” and “C” indicating their suitability for respective class of fires.

j)

3.9 FOAM BASED STORED PRESSURE TYPE PORTABLE FIRE EXTINGUISHERS:

These Extinguishers should contain AFFF (Aqueous Film Forming Foam) which is non-toxic and it works by cooling and smothering a fire. It also creates a barrier over the fuel, preventing oxygen to reach on it so the fire can’t reignite. Suitable for class A and Class B Fire.

a) PERFORMANCE & CONSTRUCTION REQUIREMENT:

PERFORMANCE	**CAPACITY – 9 lites**
Approvals/certification	IS:15683, ISI Marked & CE
Suitable for class of Fire	Class: A, B
Expelling agent	Nitrogen (UHP Grade)
Fire Rating	3A, 89B
Working/Operating Temperature (Ċ)	+5 to +55
Burst Pressure	55 Kg/cm^2
Service/Max. Service /Test Pressure	15/18/35 bar
Height (Approx.)	575 mm
Diameter (Approx.)	180 (+/- 10) mm
Gross Weight (Approx.)	14 kg
Minimum Effective Discharge Time (approx.)	35 sec
Average range of throw	6 meter
Average discharge	95%
Thickness (Approx.)	1.6 mm
Extinguishing Agent Charge	Foam

b) CONSTRUCTION: The cylinder body, expansion space, neck ring, cap, cap joint washer, hose. Nozzle and bottom ring shall be confirmed as per Indian Specification (IS: 15683).

c) MANUFACTURING TESTS: The Extinguishers shall comply all manufacturing tests specified in the IS: 15683, like leakage test, burst strength test, impact resistance test, hose assemblies test, safety locking device etc.

d) COLOUR: The colour for extinguisher bodies shall be in fire red colour confirming to IS: 05 and paint shall confirm to IS: 2932.

e) MARKING:

i The operating, recharging and inspection and maintenance instructions shall be in the form of an etched or embossed metal nameplate or band, or an acceptable pressure-sensitive nameplate attached to the side of the extinguisher body, or in the form of silk-screening of paint directly on the extinguisher body. The marking shall identify the

extinguisher as to type of media and shall include the manufacturer's name and model number and the rating and classification of the fire extinguisher.

ii The marking shall include a sequential serial number.

iii The year of manufacture, or the last two digits of the calendar year, and the factory test pressure shall permanently marked into the extinguisher body or non-transferable nameplate. Extinguishers manufactured in the first three months of a calendar year may be marked with the previous year as the date of manufacturer.

iv The marking shall include a reference to the range of temperatures at which the extinguisher is usable, such as acceptable to use at temperature from….. to ….. or the equivalent.

v The marking on each extinguisher shall include its exact gross mass or minimum and maximum gross mass, which may be expressed by a tolerance. The gross mass shall include the mass of the charged extinguisher and discharge assembly.

vi The Extinguisher shall be marked with BIS standard. The use of standard mark will be governed by the provisions of the BIS Act 1986.

vii Operating instructions: the operating instructions shall be arranged as follows:

a) Word "INSTRUCTIONS" shall be at the top of the nameplate.

b) Operating instructions shall be in the form of numerically sequenced photograph. The sequence shall be as follows:

- ✓ Making ready the extinguisher by disengaging the safety locking device,
- ✓ Aiming the extinguisher at the base of fire, included recommended distance from the fire at which to begin discharge, and indicating the intended operating attitude of the extinguisher,
- ✓ Taking whatever action necessary to initiate operation of the extinguishers, and
- ✓ Describing the intended method of applying the extinguishing media on the fire.

x. The extinguisher shall be marked with letters "A" and "B" indicating their suitability for respective class of fires.

3.10 CLEAN AGENT STORED TYPE PORTABLE FIRE EXTINGUISHERS:

These Extinguishers should contain clean agent which is a safe, clean, noncorrosive and electrically nonconductive agent, having zero Ozone Depleting Potential (ODP), a low global warming potential and a short atmospheric life. It is most suitable for sensitive electronics like computers or servers. Suitable for class A, Class B and Class C Fire.

a) <u>PERFORMANCE & CONSTRUCTION REQUIREMENT:</u>

PERFORMANCE	**CAPACITY -04KG**	**CAPACITY -06KG**
Approvals/certification	IS:15683, ISI Marked & CE	IS:15683, ISI Marked & CE
Suitable for class of Fire	Class: A, B, C	Class: A, B, C
Expelling agent	Nitrogen (UHP Grade)	Nitrogen (UHP Grade)
Fire Rating	1A, 34B	2A, 55B
Working/Operating Temperature (Ċ)	-30 to +55	-30 to +55
Burst Pressure	55 Kg/cm^2	55 Kg/cm^2
Service / Max.Service / Test Pressure	15/18/35 bar	15/18/35 bar

Minimum Effective Discharge Time (approx.)	8 - 13 sec	13 sec
Average range of throw	2 meter	2 meter
Average discharge	95%	95%
Thickness (Approx.)	1.6 mm	1.6 mm
Height (Approx.)	490 mm	530 mm
Diameter (Approx.)	140 ± 10 mm	150 ± 10 mm
Empty weight (approx.)	2.6 kg	2.9 kg
Full weight (Approx.)	6.6 kg	8.9 kg
Extinguishing Agent Charge	Clean agent: FE 36	Clean agent: FE 36

CONSTRUCTION: The cylinder body, expansion space, neck ring, cap, cap joint washer, hose. Nozzle and bottom ring shall be confirmed as per Indian Specification (IS: 15683).

b) MANUFACTURING TESTS: The Extinguishers shall comply all manufacturing tests specified in the IS: 15683, like leakage test, burst strength test, impact resistance test, hose assemblies test, safety locking device etc.

c) COLOUR: The colour for extinguisher bodies shall be in fire red colour confirming to IS: 05 and paint shall confirm to IS: 2932.

d) MARKING:

i The operating, recharging and inspection and maintenance instructions shall be in the form of an etched or embossed metal nameplate or band, or an acceptable pressure-sensitive nameplate attached to the side of the extinguisher body, or in the form of silk-screening of paint directly on the extinguisher body. The marking shall identify the extinguisher as to type of media and shall include the manufacturer's name and model number and the rating and classification of the fire extinguisher.

ii The marking shall include a sequential serial number.

iii The year of manufacture, or the last two digits of the calendar year, and the factory test pressure shall permanently marked into the extinguisher body or non-transferable nameplate. Extinguishers manufactured in the first three months of a calendar year may be marked with the previous year as the date of manufacturer.

iv The marking shall include a reference to the range of temperatures at which the extinguisher is usable, such as acceptable to use at temperature from….. to ….. or the equivalent.

v The marking on each extinguisher shall include its exact gross mass or minimum and maximum gross mass, which may be expressed by a tolerance. The gross mass shall include the mass of the charged extinguisher and discharge assembly.

vi The Extinguisher shall be marked with BIS standard. The use of standard mark will be governed by the provisions of the BIS Act 1986.

vii Operating instructions: the operating instructions shall be arranged as follows:

a) Word "INSTRUCTIONS" shall be at the top of the nameplate.

b) Operating instructions shall be in the form of numerically sequenced photograph. The sequence shall be as follows:

- ✓ Making ready the extinguisher by disengaging the safety locking device,

- ✓ Aiming the extinguisher at the base of fire, included recommended distance from the fire at which to begin discharge, and indicating the intended operating attitude of the extinguisher,
- ✓ Taking whatever action necessary to initiate operation of the extinguishers, and
- ✓ Describing the intended method of applying the extinguishing media on the fire.

viii. The extinguisher shall be marked with letters “A”, “B”, and “C” indicating their suitability for respective class of fires.

4.0 General requirements

4.1 All extinguishers shall be standard products approved by the Tariff Advisory Committee and Local Fire Authority and manufactured and tested strictly in accordance with the relevant Indian Standard. All markings and test results shall be stamped in the appropriate colour markings accordingly to the Indian Standards.

4.2 All extinguishers shall have a structurally designed galvanised steel handle and also a suitable wall mounting bracket.

5.0 Illumination signs/EXIT signage

The illuminated signs shall have the letters 'FIRE EXIT" or "NO FIRE EXIT" painted in red on a 6mm thick white perspex sheet as the front face of a sheet steel enclosure constructed with minimum 1.5mm thick sheet. The MS box shall be powder coated finished in white colour. The perspex sheet shall be back lit with a rechargeable maintenance free sealed battery integral with a battery charging circuit. The battery backup facility shall operate independent of the mains supply in the event of a mains failure. The batteries shall be of adequate rating so as to support the illumination of the signage for a minimum period of 1 hour without mains power. The preferred dimensions of the illuminated signs shall be 450 mm length and 225mm height with 100 mm high lettering. They shall be suitable for surface or recessed mounting or ceiling hung type as required including all arrangements for suspension, cutting/chasing and making good the defects etc. complete as approved.

5.0 Mode of measurement

5.1 Each extinguisher with its mounting bracket shall be measured per unit and paid for.

5.2 Exit signages with mounting plate shall be measured per sq.inch and paid for.

Fire General Parameters:

Fire NOC from local authority:

It will be in Vendor’s scope to obtain required No Objection Certificate (NOC) from the relevant Local Fire Brigade / Municipal Corporation department with all required liaisons.

To obtain provisional/advisory and final No Objection Certificate (NOC) and to ensure compliance with State specific fire safety regulations, the drawings should mandatorily be verified and approved by the State Fire Department, and it will be under the scope of the vendor.

Test Certificates:

Manufacturer's test certificates for firefighting equipment's i.e., fire pumps, fire hydrants items (landing valve, hose reel, hose box, short branch, fire brigade inlet connections etc.), fire sprinkler system, fire alarm system, fire extinguisher etc. wherever applicable on demand of Employer / Bank.

Fire Control Room:-

Fire control room should be set up at the ground floor of the building at a prominent place which should be as per the National Building Code of India. Fire Control Room shall be equipped with all the necessary fire safety equipment and gadgets as per National Building Code of India.

TERMS & CONDITIONS FOR ANNUAL MAINTENANCE CONTRACT (AMC) (UNDER WARRANTY) OF FIRE PROTECTION SYSTEM ARRANGEMENTS LIKE FIRE HYDRANT SYSTEM, FIRE EXTINGUISHER, FIRE EXTINGUISHER, FIRE SIGNAGES ETC.

Periodic maintenance of installed Fire Hydrant System, Fire Alarm System, Public Address System, Fire Extinguishers, Fire EXIT Signages etc. should be carried out as per the maintenance frequency as per BIS, NBC, bank's guidelines etc. and report to be submitted to the Bank.

1. **SCOPE OF WORK:**

   a) During warranty period of one year the scope of work in Annual Maintenance Contract shall include checking, cleaning, repairing, maintenance, and painting of complete water suppression system at the site to ensure 24x7 operation of the system. The system shall be maintained on "AS IS WHERE IS" basis. Any modification/shifting/extension of the system shall be carried out on chargeable basis.

   b) Annual maintenance Contracts for above mentioned system will be Comprehensive in nature, with free replacement of all spares and accessories, and individual equipment.

   c) Annual maintenance Contracts for above mentioned system will be Comprehensive in nature, with free replacement of all spares and accessories, except batteries, Engine Lube oil and Diesel.

   d) During the currency of the contract, the firm will attend to any number of break-down calls without any additional charges and any break down will be repaired within 72 hrs. For this purpose, communication by any means e.g., Letter, Email, SMS, Instant Messages, Mobile Phone Calls etc., which are independently logged will be considered sufficient and the vendor shall have no right to insist on any other form of communication. For all Electronic Forms of communications, the time of sending shall also be considered as time of receipt by the vendor unless the vendor is able to prove delayed receipt of such communication.

e) Any part required to be replaced shall be genuine and from Original Equipment Manufacturer (OEM). The detailed scope of works is given below:

A. DIESEL FIRE PUMP TESTING (ON QUARTERLY BASIS)

Capacity of pump shall be checked as per the prescribed manufacturer manuals and the preventive maintenance shall be as follows.

(i) Adjustment/tightening of the nuts, bolts of the pump and motor/engine and other fitments.

(ii) Checking of fuel, electrical, cooling and lubrication system of the diesel engine.

(iii) Checking and cleaning of oil bath filter, lubrication of filter, fuel filters etc.

(iv) Checking of fuel injection pump (FIP) and governor.

(v) Changing of lubrication oil (as per maintenance manual of the engine only when required).

(vi) Adjustment of valve clearance etc. as and when required.

(vii) Checking of cylinder heads nuts for specific torque in proper sequence.

(viii) Checking the batteries and testing of batteries for charged conditions with the help of measuring meter and maintenance of the battery from the corrosion.

(ix) Checking of working of alternator/Dynamo/starter.

(x) Cleaning, functional testing and servicing/maintenance of control panels.

(xi) Maintenance of exhaust manifold for leaks and tightness.

(xii) Polishing of all the brass parts.

(xiii) Fire brigade's inlet connection to be checked.

(xiv) Greasing of pump bearings, changing of peaking ropes (gland dory), and adjusting the glands.

(xv) All gauges to be tested and readings to be recorded in logbook.

(xvi) Check all the hydrant valves and close if any valve is open. Also, check that all suction and delivery connection are made properly.

(xvii) All the accessories inside the pump house and on the yard, *will be painted once in a year with Indian Standard fire red color.*

(xviii) During usual servicing/maintenance if any defects are noticed, or any recommendations/suggestions for the system improvement should be brought to the notice of the Fire Officer. Recommendation will be examined and if any alternation and addition is to be made, prior permission to be obtained and inventory to be made in the concerned logbook.

(xix) If any spare parts are required to be replaced to maintain the system for working condition, the same shall be procured by the Vendor as per the prevailing current market rates subject to the satisfaction/approval of our authorized authority and the spare parts should be original.

B. FIRE PUMP TESTING (ON QUARTERLY BASIS)

(i) Test (s) shall be conducted to determine the delivery head flow KWH and BHP of the pumps. All leaks, pressure dropping and defects in the joints, tees, elbows, valves etc. revealed during the test shall be rectified. The pumps shall also be tested for its desired performance and function by opening hydrants valves on each floor/yard separately and floor landing. The starting and cutting out pressure setting of starting devices shall also be checked for its correct operation.

(ii) Maintain all pumps joints, piping valves, accessories, pipe connections, electrical wiring motor (s) and motor control panels. The following test results shall be recorded in a separate logbook and countersigned by us.

(iii) Spare parts provided by the company (as and when required) should be of BIS specifications, ISI marked and of superior quality standards.

(iv) Polishing of all brass parts.

(v) At the time of opening any valve in the system (in case of leakage or pressure drop also) the electric pump should start automatically/manually for which the MCC and pressure vessels to be checked and maintained.

(vi) Empty the whole system once in every three months.

(vii) Check all hydrant valves. Also, check that all suction and delivery connections are properly functional.

(viii) Test run and check rotation of each motor and correct the same if required.

(ix) Fire Brigade inlet connection to be checked.

(x) Greasing of pump bearings, changing of packing ropes, and adjust the glands.

(xi) All gauges to be tested and readings to be recorded.

(xii) Once **in three months'** hose pipe drill to be carried out. The hose pipes 63mm dia (RRL/Non-percolating/CP) to be tested. Check each landing valve male female couplings and branch pipes for compatibility with each other.

C. OTHER ACCESSORIES (ON QUARTERLY BASIS): -

(i) **Butterfly Valve/Sluice Valve:** -Regular cleaning of deposits/scales on the wedges flaps gates changing of packing rope changing of the gasket changing of rusted nuts and bolts greasing and leakage arresting.

(ii) **Non-return valve:** Regular cleaning of deposits/scales on the wedges. Inside flaps etc. changing of rubber gaskets and leakage arresting.

(iii) **Air Release valve:** -Cleaning greasing of spring adjustment of spring tension etc.

(iv) **Pressure switches:** -Testing of pressure switches.

(v) **Control panel: -**Testing of control panel for pumps for all functions and the readings to be recorded in the logbook.

(vi) Open hydrant valve and allow the water to flow into the firewater tank in order to avoid wastage of water the main fire pump should start at the pre-set pressure.

(vii) The entire hydrant opening should be pressure tested and same should be logged in logbook.

D. TESTING OF ELECTRICAL PANELS & STARTER (ON QUARTERLY BASIS):-

(i) Operation of all instruments and meters provided on the electrical panel board.

(ii) Tightening of all electrical contacts on quarterly basis.

E. PIPE WORK (ON QUARTERLY BASIS): -

(i) Check the entire clamp supports provided for the pipes.

(ii) Check rusting of pipes from within / outside at joints.

(iii) Painting of Water pipes (double coat) **once in a year (prefer in second quarter) with Indian standard fire red colour.**

F. OBTAINING OF NO OBJECTION CERTIFICATE

(i) If local fire brigade insists for inspection by their competent authority for the fire and fire safety measures, firefighting tools, apparatus etc. and to carry out still photography and video recording as an evidence that it has to be arranged and handed over to the Competent authority.

(ii) **Renewal of Fire NOC (Fire Certificate) from Local Fire Brigade will have to be done by the vendor. *(License fee will be paid by the vendor & to be reimbursed from the Bank).***

MAINTENANCE SCHEDULE OF FIXED FIRE PROTECTION SYSTEM ARRANGEMENTS

A. DIESEL FIRE PUMP TESTING (ON QUARTERLY BASIS)

S.NO.	PARTCULARS OF TASK	DATE	REMARKS
1.	Adjustment/tightening of the nuts, bolts of the pump and motor/engine and other fitments.		
2.	Checking of fuel, electrical, cooling and lubrication system of the diesel engine.		
3.	Checking and cleaning of oil bath filter, lubrication of filter, fuel filters etc.		
4.	Checking of fuel injection pump (FIP) and governor.		
5.	Changing of lubrication oil (as per maintenance manual of the engine only when required).		

6.	Adjustment of valve clearance etc. as and when required.		
7.	Checking of cylinder heads nuts for specific torque in proper sequence.		
8.	Checking the batteries and testing of batteries for charged conditions with the help of measuring meter and also maintenance of the battery from the corrosion.		
9.	Checking of working of alternator/Dynamo/starter.		
10.	Cleaning, functional testing and servicing/maintenance of control panels.		
11.	Maintenance of exhaust manifold for leaks and tightness.		
12.	Polishing of all the brass parts.		
13.	Fire brigade's inlet connection to be checked.		
14.	Greasing of pump bearings, changing of peaking ropes (gland dory) and adjusting the glands.		
15.	All gauges to be tested and readings to be recorded in logbook.		
16.	Check all the hydrant valves and close if any valve is open. Also, check that all suction and delivery connection are made properly.		

B. FIRE PUMP TESTING (ON QUARTERLY BASIS)

1.	Test (s) shall be conducted to determine the delivery head flow KWH and BHP of the pumps. All leaks, pressure dropping and defects in the joints, tees, elbows, valves etc. revealed during the test shall be rectified. The pumps shall also be tested for its desired performance and function by opening hydrants valves on each floor/yard separately and floor landing. The starting and cutting out pressure setting of starting devices shall also be checked for its correct operation.		
2.	Maintain all pumps joints, piping valves, accessories, pipe connections, electrical wiring motor (s) and motor control panels. The following test results shall be recorded in a separate logbook and countersigned by us.		

	a) Polishing of all brass parts. b) At the time of opening any valve in the system (in case of leakage or pressure drop also) the electric pump should start automatically/manually for which the MCC and pressure vessels to be checked and maintained. c) Empty the whole system once in every three months. d) Check all hydrant valves. Also, check that all suction and delivery connections are properly functional. e) Test run and check rotation of each motor and correct the same if required. f) Fire Brigade inlet connection to be checked. g) Greasing of pump bearings, changing of packing ropes, and adjust the glands. h) All gauges to be tested and readings to be recorded.		

C. FIRE FIGHTING SYSTEM (OTHERS) (ON QUARTERLY BASIS): -

1.	Butterfly Valve/Sluice Valve: -Regular cleaning of deposits/scales on the wedges flaps gates changing of packing rope changing of the gasket changing of rusted nuts and bolts greasing and leakage arresting.		
2.	Non-return valve: Regular cleaning of deposits/scales on the wedges. Inside flaps etc. changing of rubber gaskets and leakage arresting.		
3.	Air Release valve: -Cleaning greasing of spring adjustment of spring tension etc.		
4.	Pressure switches: -Testing of pressure switches.		
5.	Control panel: -Testing of control panel for pumps for all functions and the readings to be recorded in the logbook.		
6.	Open hydrant valve and allow the water to flow into the firewater tank in order to avoid wastage of water the main fire pump should start at the pre-set pressure.		
7.	The entire hydrant opening should be pressure tested and same should be logged in logbook.		
8.	TESTING OF ELECTRICAL PANELS & STARTER (ON QURTERLY BASIS): - a) Operation of all instruments and meters provided on the electrical panel board. b) Tightening of all electrical contacts on quarterly basis. c) Hooter alarm system		

9.	PIPE WORK (ON QUARTERLY BASIS): - a) Check the entire clamp supports provided for the pipes. b) Check rusting of pipes from within / outside at joints		
10.	**SPRINKLER SYSTEM:** □ Checking of the whole sprinkler pendent in the building.		
	□ Pressurization system		

NOTE: - *Spare parts provided by the company (as and when required) should be of BIS specifications, ISI marked and of superior quality standards. All the accessories inside the pump house and on the yard, will be painted once in a year with Indian Standard fire red colour.*

SECTION - V

ELECTRICAL WORK

1.0 Scope

1.1 The scope of this section comprises of fabrication, supply, erection, testing and commissioning of electric panels, wiring and earthing of all equipment components and accessories, including supply, installation and wiring of remote mounted push button stations.

1.2 All the electrical cables, termination, wires and accessories are also including in the Scope of Work. The main cable from the main distribution board will be supplied and erected by other Agency.

2.0 General

2.1 Work shall be carried out in accordance with the specifications of CPWD specifications, Indian Electricity Act 1910 and Indian Electricity Rules 1956 as amended up to date.

3.0 Construction Features

3.1 The control panel shall be metal enclosed sheet steel cubical, indoor type, floor mounting/wall mounting type as per BS 5486 Part 1, 190 & IEC 439-1. The control panel shall be totally enclosed, completely dust and vermin proof, Gaskets between all adjacent units and beneath, covers shall be provided to render the joints dust proof. Control panels shall be arranged in multitier formations. All doors and covers shall also have sealing & pad locking arrangement. All mild steel sheets used in the construction of control panels shall be minimum 2mm. thick or as specified 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 slag grounded off and welding pits wiped smooth with plumber metal.

3.2 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 provided with hank nuts. Self threading screws shall not be used in the construction of control panels. Base channel shall be of 75mm x 40mm x 5mm thick shall be provided at the bottom. Minimum clear space of 250 mm between top of channel of control panel and bottom most unit shall be provided.

3.3 The control panels shall be of adequate size with a provision of 10% spare space to accommodate possible future additional switchgear. Knockout holes of appropriate size and number of cables 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 both above and below the control panel. Where cables enter below, cables boxes shall be fitted at the rear and arranged in tiers to facilitate making connections to the upper and lower units. Clamps shall be provided to support the weight of the cables. All incoming and outgoing feeders shall be brought out to a terminal block of adequate size at suitable location inside the

control panel. All wiring inside the control panel shall be color coded and labeled with approved plastic beads for identification. Circuit diagrams showing the arrangement of circuits shall be pasted on the inside of the panel door and covered with transparent plastic sheet and all labeling shall be provided on the front face of the panel board.

4.0 Circuit Compartments

4.1 Each circuit breaker, contactor and relay shall be housed in a separate compartment and shall be enclosed on all sides. 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 the draw out position of the panel. Instruments and indicating lamps shall not be mounted on the panel compartment door. Sheet steel barriers shall be provided between the tiers in a vertical section.

5.0 Instrument Accommodation

5.1 Separate and adequate compartments shall be provided to accommodate instruments, indicating lamps, control contactors and control fuses etc. These shall be accessible for testing and maintenance without any danger of accident contact with live parts of the circuit breaker and bus bar.

6.0 Bus Bars and Bus bar Connection

6.1 The bus bar and interconnections shall be of aluminum and of rectangular cross sections suitable for full load current for phase bus bars and half rated current for neutral bus bars and shall be extensible on either side. The bars and interconnections shall be insulated with PVC heat shrinkable sleeve and color coded. All bus bars shall be supported on unbreakable, non-hygroscopic insulated SMC/DMC type supports at regular intervals not more than 400 mm, to withstand the forces arising in case of short circuit in the system. Bus bars shall be provided in separate chamber of main control panels shall be connected by clamping, no holes shall be drilled in bus bars. If holes have to be drilled for making connections, extra cross section of bus bars shall be provided.

6.2 All bus bar connections in smaller control panels shall be done by drilling hole and connecting by brass bolts and nuts. Additional cross section of bus bars shall be provided in small control panels to cover up the holes drilled in the bus bars.

6.3 All connections between the bus bar and breaker and between breaker and contactor shall be through copper strips of proper size to carry full rated current and shall be insulated with coloured PVC heat shrinkable sleeve.

7.0 Terminals

7.1 The outgoing terminals and neutral links shall be brought out to a terminal block suitably located in the control panels. The current transformer for instruments, metering and for protection shall be mounted on the terminal blocks. Separate cable compartment shall be provided for incoming and outgoing cables.

8.0 Wire ways

8.1 A horizontal wire way screwed covers shall be provided at the top to take in the connecting control wiring of different vertical sections.

9.0 Cable Compartments

9.1 Cable compartments/alley of adequate size shall be provided in the control panels for easy termination of all incoming and outgoing cables entering from bottom or top using detachable gland plates with proper knockouts. Adequate and proper DMC supports shall be provided in cable compartments to support cables. All incoming and outgoing terminals shall be brought out on terminal blocks in the cable compartment.

10.0 Materials

a) Rotary Switches

Switches up to 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. The terminals shall be shrouded with insulation to prevent accidental contact with live parts. Rotary switches shall be backed up with moulded type HRC fuse fittings of appropriate rating.

b) Selector Switch

When called for, selector switches of rated capacity shall be provided in control panels, to give the choice of operating equipment in selective mode.

c) Molded Case Circuit Breakers (MCCB)

MCCBs shall be quick make, quick break, and preferably double break contact system, arc extinguishing device, independent manual type with trip free feature with mechanical ON, OFF, and TRIP indications as called for in BOQ. A trip button shall be provided for tripping the breaker.

MCCB shall be a compact high strength, heat resistant, flame retardant; insulating molded case with high withstands capability against thermal and mechanical stresses. All MCCBs shall be capable of defined variable overload adjustment

d) Switches

Switches beyond 60 amps shall be panel mounted double break type and suitable for load break duty, quick make and break action. Switch contacts shall be silver plated and shall be back-up with HRC fuses of appropriate rating. The switch handles shall be located at the front.

e) HRC Fuses

Fuses shall be high Rupturing capacity of not less than 20 MVA at 415 volts. The backup fuse rating of each motor/heater/equipment shall be so chosen that the fuse does not operate on starting of motor/heater/equipment. Fuses shall be of the same make as the switches.

f) Starters

Each motor shall be provided with a starter of suitable rating. Direct on line starters shall be provided for motors up to 10 HP.

Operating coils of contactors shall be suit able for 220/415 +/- 10% volts AC, 50 cycles supply system. The contactor shall drip out when voltage drops to 90% of the rated voltage.

g) Over Load Relays

Contactors shall be provided with a three element, positive acting ambient temperature compensated time lagged hand-reset type thermal over load relay with adjustable setting.

h) Current Transformers

Current Transformer shall be of accuracy class - I and suitable VA burden for operation for the connected meters and relays.

i) Single Phase Preventor

Single phase preventor shall be provided for all the starters. Single phase preventor shall act when the supply voltage drops down to 90% of the rated voltage or on failure of one or more phases.

j) Indicating Lamp and Metering

The meters shall be flush mounted and draw-out type. The indicating lamp shall be neon type and of low burden. Each phase indicating lamp shall be backed up with 2 amps fuse.

k) Push Button Stations

Push button station shall be for manual starting and stopping of motors/equipment as called for. Red and Green colour push buttons shall be provided for starting and stopping operations. Push buttons shall be suitable for panel mounting and accessible from front without opening door.

m) Cables

M.V. cables shall be PVC insulated aluminium conductor armoured cables suitable for laying in trenches, duct, and on cable trays as required.

n) Wires

650/1100 volts grade PVC insulated copper conductor wires in conduit shall be used.

11.0 Cable Laying

11.1 Easy 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 minimize the loss in current carrying capacity with necessary saddling/clamps.

12.0 Earthing

12.1 The earthing of MCC and equipment shall be as per BIS Specification and considered in the main electrical panel. The loop earthing shall be carried out with G.I/Copper

Strips/wires.

13.0 Painting for Panel

13.1 All sheet steel work shall undergo a process of seven tank treatment and painting with powder coating paint of approved shade.

14.0 CABLE WORK

This section covers detailed requirements for supply, laying, testing and commissioning of cables.

14.1 GENERAL

MV cable 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 drum.

14.2 **MATERIAL**

14.2.3 The MV power cable of 660/1100 V. grade shall be PVC insulated Aluminium conductor armoured cable conforming to IS : 1554 (part - I). MV cable shall be 3.5/4 core of size and type as specified.

14.2.4 The MV control cables shall be PVC insulated copper conductor armoured cable.

14.3 STORAGE AND HANDLING

14.3.15 All cables shall be inspected upon receipt at site and checked for any damage during transit.

14.3.16 Cable drums shall be stored on a well drained, hard surface, preferably of concrete, so that the drums do not sink in the ground causing rot and damage to the cable drums.

14.3.17 During storage periodical rolling of drums once in 3 months through 90^{o} shall be done. Rolling shall be done in the direction of the arrow marked on the drum.

14.3.18 It should be ensured that both ends of the cable are properly sealed to prevent ingress/absorption of moisture by the insulation.

14.3.19 Protection from rain and sun shall be ensured. Sufficient ventilation between cable drums, should be ensured during storage.

14.3.20 The drums shall always be rested on the flanges and not on the flat sides.

14.3.21 Damaged battens of drums etc. should be replaced, if necessary.

14.3.22 When cable drums have to be moved over short distances, they should be rolled in the direction of the arrow, marked on the drum.

14.3.23 For transportation over long distances, the drum should be mounted on cable drum wheels strong enough to carry the weight of the drum and pulled by means of

ropes. Alternatively, they may be mounted on a trailer or on a suitable mechanical transport.

14.3.24 When unloading cable drums from vehicles, a crane shall preferably be used. Otherwise the drum shall be rolled down carefully on a suitable ramp or rails, where necessary.

14.3.25 While transferring cable from one drum to another, the barrel of the new drum shall have a diameter not less than that of the original drum.

14.3.26 The cables shall not be bent sharp to a small radius. The minimum safe bending radius for all types of PVC cables shall be taken as 12 times the overall diameter of the cable. Wherever practicable, larger radius should be adopted. At joints and terminations, the bending radius of individual cores of a multi core cable shall not be less than 15 times its overall diameter.

14.3.27 Cable with kinks and straightened kinks or with similar apparent defects like defective armouring etc. shall be rejected.

14.3.28 Cables from the stores shall be supplied by the contractor as per the site requirement in pieces cut in the stores.

14.4 **INSTALLATION**

14.4.1 **GENERAL**

The cable installation including necessary joints shall be carried out in accordance with the specifications given herein. For details not covered in these specifications, I.S.:1255 shall be followed. No straight through joint shall be permitted in the system. The cables shall be supplied as per cable schedule submitted by the contractor & approved by Engineer-in-Charge.

14.4.2 **ROUTE**

14.4.2.8 Before the cable laying work is undertaken, the route of the cable shall be decided by the Architect in consultation with Owner representative.

14.4.2.9 While shortest practicable route shall be preferred, cable runs shall generally follow fixed developments such as roads, foot-paths etc. with proper offsets so that future maintenance, identification etc. are rendered easy. Cross country run to shorten the route length is not desirable as it would lead to route identification and maintenance problems, besides posing difficulties during later development of open areas etc.

14.4.2.10 While selecting cable routes, corrosive soils, ground surrounding sewage and effluent etc. shall be avoided. Where this is not feasible, special precautions as approved by the Architect shall be taken.

14.4.2.11 As far as possible, the alignment of the cable route shall be decided taking into consideration the present and future requirements of other agencies and utility services affected by it, the existence of any cable in the vicinity as may be indicated by cable markers or cable schedules or drawing maintained for that area, possibilities of widening of roads/lanes, storm water drains etc. Cable routes shall be planned away from the drains and should be within the property.

14.4.2.12 Whenever cables are laid along well demarcated or established roads, the MV cables shall be laid further from the kerb line than HV cables.

14.4.2.13 Cables of different voltages and also power and control cables shall be kept in different trenches with adequate separation. Where available space is restricted, MV cables shall be laid above HV cables.

14.4.2.14 Where cables cross one another the cable of higher voltage shall be laid at a lower level than the cable of lower voltage.

14.5 WAY LEAVE

14.5.1 It may be necessary to obtain way leave for the cable route from the appropriate authorities some of whom are listed below:

a) Drainage, Public Health and Water Works.
b) Telephones and Telegraphs.
c) Gas works.
d) Other Undertakings.
e) Owners of properties.

14.5.2 Where necessary, joint inspection with representatives of other authorities may be arranged so that mutual interests are safeguarded. In case of private property, Section 12/51 of the Indian Electricity Act shall be complied with.

14.6 PROXIMITY TO COMMUNICATION CABLES

Power and communication cables shall as far possible cross at right angles. Where power cables are laid in proximity communication cables the horizontal and vertical clearances shall not normally be less than 60 cms.

14.6.1 LAYING METHODS

14.6.1.1 Cables shall be laid direct in ground or in pipes/closed ducts, in open ducts or on cable trays suspended from slab depending on site conditions.

14.6.2 Laying in Pipes/Closed ducts :

14.6.2.10 In location such as road crossing, entry to building, on poles, in paved areas etc. cables shall be laid in pipes or closed ducts.

14.6.2.11 GI or Hume Pipes (spun reinforced concrete pipes) shall be used for such purposes. In the case of new construction, pipes as required shall be laid along with the Civil works and jointed according to the instructions of the Engineer-in-Charge as the case may be. The size of pipe shall be as indicated in the electrical drawings. GI pipe shall be laid directly in ground without any special bed. Hume pipe (Spun reinforced concrete pipe) shall be laid over 10 cm. thick cement concrete 1:5:10 (1 cement : 5 coarse sand : 10 graded stone aggregate of 40mm nominal size) bed, after which it shall be completely embedded in concrete. No sand cushioning or tiles need be used in such situations. Unless otherwise specified, the top surface of pipes shall be at a minimum depth of 1mtr. from the ground level when laid under roads, pavement etc.

14.6.2.12 Where steel pipes are employed for protection of single core cables feeding AC load, the pipe should be large enough to contain both cables in the case of single phase system and all cables in the case of polyphase system.

14.6.2.13 The pipes on road crossing shall preferably be on the skew to reduce the angle of bends as the cable enters and leaves the crossings. This is particularly important for high voltage cables.

14.6.2.14 Manholes of adequate size as decided by the Engineer-in-Charge shall be provided to facilitate feeding/drawing in of cables and to provide working space for persons. They shall be covered by suitable manhole covers with frame of proper design. The construction of manholes and providing the cover is not in the scope of this Contract and shall be got executed and paid for by the Engineer-in-Charge through another agency.

14.6.2.15 Pipes shall be continuous and clear of debris or concrete before cable is drawn. Sharp edges at ends shall be smoothened to prevent injury to cable insulation or sheathing.

14.6.2.16 Pipes for cable entries to the building shall slope downwards from the building and suitably sealed to prevent entry of water inside the building. Further the mouth of the pipes at the building end shall be suitably sealed to avoid entry of water. This seal in addition to being waterproof shall also be fireproof.

14.6.2.17 All chases and passages necessary for lying of service cable connections to buildings shall be cut as required and made good to the original finish and to the satisfaction of the Engineer-in-Charge.

14.6.2.18 Cable grips/draw wires and winches etc. may be employed for drawing cables through pipes/closed ducts etc.

14.6.3 **Laying on Cable Trays**

14.6.3.1 Cables, where indicated in approved shop drawings, shall be laid on overhead cable trays which are suspended from ceiling or supported from wall, by anchor fasteners as required.

14.6.3.2 The Contractor shall provided for all accessories for the installation of the cable trays, such as bends, tees, reducers coupler plates, trifoil clamps and structural steel members (comprising of channels, angles, flats, rods) to be fabricated at site for structural supports for cable trays racks etc.

14.6.4 **Termination**

Brass single compression glands shall be provided for MV cables termination

14.6.5 **Testing**

14.6.5.3 All 650/1100 Volt grade cables before laying shall be tested with a 500 V megger or with a 2,500/5,000 V megger for cables of higher voltages. The cable cores shall be tested for continuity, absence of cross phasing, insulation resistance to earth/sheath/armour and insulation resistance between conductors.

14.6.5.4 All cables shall be subject to above mentioned tests during laying, before covering the cables by protective covers and back filling and also before the jointing operations.

15.0 CABLE TRAYS

15.4 Prefabricated Cable trays of ladder type and associated accessories, tees, bends, elbows & reducers shall be fabricated from 12 gauge (2.6 mm thick) mild steel. Perforated cable trays and associated accessories tees, elbows, and reducers shall be fabricated from 14 guage (2 mm thick) MS steel.

15.5 Cable trays and accessories and covers shall be painted with one shop coat of red oxide zinc chromate primer and two coats of Aluminium alkyd paint.

15.6 The Contractor shall provide for all accessories for the installation of the cable trays, such as bends, tees, reducers coupler plates, trifoil clamps and structural steel members (comprising of channels, angles, flats, rods) to be fabricated at site for structural supports for cable trays racks etc.

16.0 EARTHING

This section covers detailed requirements for earthing.

16.1 GENERAL

16.1.5 The non-current carrying metal parts of electrical installation shall be earthed properly. All metallic structure, enclosures, junction boxes, outlet boxes, cabinets, machine frame, portable equipments, metal conduits, trunking, cable armour, switchgear, distribution boards, lighting fittings and all other parts made of metal in close proximity with electrical circuits shall be bonded together and connected by means of specified earthing conductors to an efficient earthing system. All earthing will be in conformity with the relevant Indian Electricity Rules 1956 and Indian Standard Specification IS : 3043. Every item of equipment served by the electrical system shall be bonded to earthing system.

16.1.6 Every switch, lighting fixture and 5 Amp outlets shall be provided with insulated copper conductor of 1.5 sq. mm for earthing. The computer workstations shall be earthed with 2.5 sq.mm. insulated copper conductor wire.

16.1.7 Separate copper earth pits shall be provided for UPS, EPABX & Networking equipment.

16.1.8 The raceways shall not be used as a grounding conductor.

16.2 CONNECTION OF EARTHING CONDUCTORS

16.2.1 Main earthing conductor shall be taken from the earth connections at the PDB to the earthing pit. Circuit earthing conductor shall run from the exposed metal of equipment and shall be connected to any point on the main earthing conductor, or its distribution boards or to an earth leakage circuit breaker. Metal conduits, cable sheathing and armouring shall be earthed at the ends adjacent to switch boards at which they originate, or otherwise at the commencement of the run by an earthing conductor in

effective electrical contact with cable sheathing. Where equipment is connected by flexible cord, all exposed metal parts of equipment shall be earthed with 2 no. G.I. strips/wires and non-current carrying metallic parts with, 1 no. G.I. strips/wires.

16.2.2 Neutral conductor, sprinkler pipes, or pipes conveying gas, water or inflammable liquid, structural steel work, metallic enclosures cables and conductors, metallic conduits and lightning protection system conductors shall not be used as a means of earthing an installation or even as a link in earthing system. The Electrical resistance of metallic enclosures for cables and conductors measured between earth connections at the main switch boards and any other point on the completed installation shall be low enough to permit the passage of current necessary to operate circuit breakers and shall not exceed 1 OHM.

16.3 EARTH CONNECTIONS

All metal clad switches and other equipment carrying single phase circuit, shall be connected to earth by a single connection. All metal clad switches carrying 3 phase shall be connected with earth by two separate and distinct connections. The earthing conductor inside the building wherever exposed shall be properly protected from mechanical injury by running the same in GI pipe of adequate size. The earthing conductor shall be painted to protect it against corrosion. Earthing conductor outside the building shall be laid 600 mm below finished ground level. The over lapping in **G.I.** strips in joints shall be welded. Lugs of adequate capacity and size shall be used for all termination of conductor wires. Lugs shall be bolted to the equipment body to be earthed after the metal is cleaned of paint and other oily substance and properly tinned.

16.4 PROTECTION FROM CORROSION

Connection between copper and galavanised equipment shall be made on vertical face and protected with paint and grease. Galvanised fixing clamps shall not be used for fixing earth conductors. Only copper fixing clamp shall be used for fixing earth conductors. When there is evidence that the soil is aggresive to copper, buried earthing conductors shall be protected by suitable serving and sheathing.

16.5 EARTHING STATION

16.5.1 PLATE ELECTRODE EARTHING

16.5.1.3 Earthing electrode shall consist of a Copper plate of 600 mm X 600 mm X 3 mm or G.I. plate of 600mm x 600mm x 6.3 mm as called for in the Schedule of Quantity. The plate electrode shall be buried as far as practicable below permanent moisture level but in any case not less than 3 meters below ground level. Wherever possible, earth electrode shall be located as near the water tap, water drain or a down take pipe as possible. Earth electrode shall be kept clear of the building foundations and in no case shall it be nearer than 2 meters from the outer surface of the wall.

16.5.1.4 The earth plate shall be set vertically and surrounded with 150 mm thick layer of charcoal dust and salt mixture. A 20 mm dia GI pipe shall run from the top edge of the plate to the ground level. The top of the pipe shall be provided with a funnel and a mesh for watering the earth through the pipe. The funnel over the GI pipe shall be housed in a masonry chamber approximately 300 mm x 300 mm x 300 mm deep. The masonry chamber shall be provided with a cast iron cover resting over a CI frame. Test facility shall be provided with test links for the earthing station.

16.5.2 PIPE ELECTRODE EARTHING

Earthing Electrode shall consist of G.I. medium class. 40 mm dia 4.5 m long pipe (without any joint) G.I. pipe Electrode shall be cut, tapered at the bottom and provided

with holes of 12 mm dia drilled not, less than 7.5 cm from each other upto 2 M of length from the bottom. Pipe electrode shall be buried in the ground vertically with its top at not less than 200 mm below the ground level. When more than one pipe is to be installed a separation of not less than 2 M shall be maintained between two adjacent electrodes as called for in the drawings. Wherever possible, earth electrode shall be located as near the water tap, water drain or a down take pipe as possible. Earth electrode shall be kept clear of the building foundations and in no case shall it be nearer than 2 meters from the outer surface of the walls. The pipe electrode shall be set vertically and surrounded with 150 mm thick layer of charcoal dust and salt mixture. A 40 mm x 20 mm reducer shall be used for fixing of funnel with mesh. The funnel and mesh have been provided for watering the earth through the pipe. The funnel over the G.I. Pipe shall be housed in a masonry chamber 300mm x 300mm x 300mm. deep. The masonry chamber shall be provided with a cast iron cover resting over a CI frame. The breaked earth pit will be provided with test links in suitable enclosures.

16.5.3 **ARTIFICIAL TREATMENT OF SOIL**

If the earth resistance is too high and the multiple electrode earthing does not give adequate low resistance to earth, as specified in Clause no. 7 then the soil resistivity immediately surrounding the earth electrodes shall be reduced by adding sodium chloride, Calcium chloride, sodium carbonate, copper sulphate, salt and soft coke or charcoal in suitable proportions.

16.5.5 **RESISTANCE TO EARTH**

The resistance to each earthing system shall not exceed 1.0 ohm.

COMMISSIONING & GUARANTEE

1. SCOPE OF WORK

Work under this section shall be executed without any additional cost. The rates quoted in this tender shall be inclusive of the works given in this section.

Contractor shall provide all tools, equipment, metering and testing devices required for the purpose.

On award of work, Contractor shall submit a detailed proposal giving methods of testing and gauging the performance of the equipment to be supplied and installed under this contract.

All tests shall be made in the presence of the Architect or his representative or any inspecting authority. At least five working days notice in writing shall be given to the inspecting parties before performing any test.

Water flow rates of all equipment and in pipe lines through valves shall be adjusted to design conditions. Complete results of adjustments shall be recorded and submitted.

Contractor shall ensure proper balancing of the hydraulic system and for the pipes / valves installed in his scope of work by regulating the flow rates in the pipe line by valve operation. The contractor shall also provide permanent Tee connection (with plug) in water supply lines for ease of installing pressure gauge, temperature gauge & rotameters. Contractor shall also supply all required pressure gauge, temperature gauge & rotameter for system commissioning and balancing. The balancing shall be to the satisfaction of Consultant / Project Manager.

Three copies of all test results shall be submitted to the Engineer in A4 size sheet paper within two weeks after completion of the tests.

2 PRECOMMISSIONNIG

On completion of the installation of all pumps, piping, valves, pipe connections, insulation etc. the Contractor shall proceed as follows:

2.1 Prior to start-up and hydraulic testing, the Contractor shall clean the entire installation including all fitments and pipe work and the like after installation and keep them in a new condition. All pumping systems shall be flushed and drained at least once through to get rid of contaminating materials. All pipes shall be rodded to ensure clearance of debris, cleaning and flushing shall be carried out in sections as the installation becomes completed.

e) All strainers shall be inspected and cleaned out or replaced.

f) Check all clamps, supports and hangers provided for the pipes.

g) Check all the equipment, piping and valves coming under hot water system and operate each and every valve on the system to see if the valves are functioning properly. Thereafter conduct & hydro test of the system as for (b) above.

h) Fill up pipes with water and apply hydrostatic pressure to the system as given in the relevant section of the specification. If any leakage is found, rectify the same and retest the pipes.

3 FINAL ACCEPTANCE TESTS

Following commissioning and inspection of the entire installation, and prior to issue of the Completion Certificate, the Contractor shall carry out final acceptance tests in accordance with a programme to be agreed with the Architect.

Should the results of the acceptance tests show that plant, systems and/or equipment fail to perform to the efficiencies or other performance figures as given in this Specification, the Contractor shall adjust, modify and if necessary replace the equipment without further payment in order that the required performance is obtained.

Where acceptance tests are required by the relevant Authorities having jurisdiction, these tests shall be carried out by the Contractor prior to the issue of Completion Certificate to the acceptance of the Authorities.

4 REJECTION OF INSTALLATION / PLANT

Any item of plant or system or component which fails to comply with the requirements of this Specification in any respect whatsoever at any stage of manufacture, test, erection or on completion at site may be rejected by the Architect either in whole or in part as he considers necessary/appropriate. Adjustment and/or modification work as required by the Architect so as to comply with the Authority's requirements and the intent of the Specification shall be carried out by the Contractor at his own expense and to the satisfaction of the Authority/Architect.

After works have been accepted, the Contractor may be required to carry out assist in carrying out additional performance tests as reasonably required by the

Architect/Employer.

5. WARRANTY AND HANDOVER

The Contractor shall warrant that all plant, materials and equipment supplied and all workmanship performed by him to be free from defects of whatsoever nature before handover to the Owner.

6. HANDING OVER OF DOCUMENTS

All testing and commissioning shall be done by the Contractor to the entire satisfaction of the Owner's site representative and all testing and commissioning documents shall be handed over to the Owner's site representative.

The Contractor shall also hand over all maintenance and operation manuals, all certificates and all other documentation as per the terms of the contract to the Owner's site representative.

E.DECLARATION

(To be typed and given on the letter – head of the Vendor)

I/We have inspected all the sites of the **Construction of Multi-Storey Building for Administrative Office, RBO, SBILD, SME branch, RASMEC, AMCC and Guest House at Bank Plot of land at Deoghar** of State Bank of India and I/We have made me/ us fully acquainted with the local conditions in and around the sites of works and proposed layout drawings of works, drawings of each items, TENDER, Technical bid & Price bid, etc. complete.

I/We hereby declare that I/ We have carefully gone through the conditions laid down in the Notice Inviting Tender, General notes, General Conditions of Contract, Special conditions, Schedule of approximate quantities and rates , Form of Agreement, General Specification, Approved manufacturers/ natural source of materials (i.e. all parts of Technical bid), Technical Specifications of schedule of quantities (i.e. all parts of Price bid), and clearly understood all the same and on the basis of the same I/ We have quoted our rates in the Schedule of Quantities/ Price Bid attached with the tender documents.

We accept all the terms and conditions of tender documents. We will abide by the technical specification mentioned in the tender. We here by undertake to use only specified material/ make as per the tender schedule.

I/ We hereby declare that, in particular during execution of all works at site; it will be my/ our sole responsibility to strictly adhere to/ meticulously follow the General Specification, Approved manufacturers/ natural source of materials; Safety, Health and Environmental (SHE) guidelines; Labour Laws; Technical Specifications of schedule of quantities, all drawings of layout and items.

For any type of deviation (to any of above or subsequent instructions), it will be my/our responsibility to obtain the written instruction of the APMCF/SBI, appropriate Government Authorities, local bodies for the same failing which it shall be deemed that I have carried out any such deviations at my own and I shall be duty bound to replace all the deviated material/ works from the site at my/ our cost as well as I shall be liable to penalized by the employer as deemed fit and for all such loses made thereof, I/ we shall not have any right to arbitrate in any manner.

I/ We hereby declare that I/ We shall obtain necessary clarifications, drawings of items from APMCF/SBI in time and shall uniformly maintain such progress as may be directed by the APMCF/SBI to ensure completion of same within the target date/ time as mentioned in the tender document.

Date: Signature and seal of Contractor/Tenderer

Witness:

1.

2.