EPC TENDER

FOR

DESIGN, CONSTRUCTION, TESTING, COMMISSIONING AND VALIDATION OF BSL-3 LABORATORY, BSL-2 LABORATORY & ANIMAL FACILITY (EPC MODE) INCLUDING OPERATION & MAINTENANCE

AT

INSTITUTE OF ADVANCED VIROLOGY, THONNAKKAL, THIRUVANANTHAPURAM

Tender No. HITES/IDS/IAV-BSL/23/28
[e-tender ID: 2024_HITE_189396_1]

VOLUME- 5

TECHNICAL SPECIFICATIONS

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TECHNICAL SPECIFICATIONS
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SECTION - I

TECHNICAL SPECIFICATIONS FOR CIVIL WORKS
PLUMBING WORKS
FIRE FIGHTING WORKS
DRAINAGE WORKS
EXTERNAL DEVELOPMENT WORKS
CIVIL MISCELLANEOUS WORKS

1.0 GENERAL

1.1 The specifications for Civil and Plumbing works shall be in accordance with C.P.W.D. specifications Volumes I and II with up to date correction slips unless otherwise specified in the nomenclature of individual item or in the specifications. The entire work shall be carried out as per the C.P.W.D. specifications in force with up to date correction slips upto the date of opening of tender.

1.2 For the item not covered under CPWD Specifications mentioned above, the work shall be executed as per latest relevant standards/codes published by B.I.S. (formerly ISI) inclusive of all amendments issued thereto or revision thereof, if any, upto the date of opening of tenders.

1.3 In case of B.I.S. (formerly I.S.I) codes/specifications are not available, the decision of the Engineer based on acceptable sound engineering practice and local usage shall be final and binding on the contractor.

1.4 However, in the event of any discrepancy in the description of any item as given in the tender drawing or specifications appended with the tender and the specifications relating to the relevant item as per CPWD specifications mentioned above, the decision of Engineer-in-charge shall prevail.

1.5 The work shall be carried out in accordance with the architectural, structural, plumbing and electrical drawings etc. The drawings shall have to be properly co-related before executing the work. In case of any difference noticed between the drawings, final decision, in writing of the Engineer shall be obtained by the contractor. For items, where so required, samples shall be prepared before starting the particular items of work for prior approval of the Engineer and nothing extra shall be payable on this account.

1.6 All materials to be used on works shall bear I.S. certification mark unless specifically permitted otherwise in writing. In case I.S. marked materials are not available (not produced), the materials used shall conform to I.S. Code or CPWD specifications, as applicable in this contract.

In such cases the Engineer shall satisfy himself about the quality of such materials and give his approval in writing. Only articles classified as "First Quality" by the manufacturers shall be used unless otherwise specified. All materials shall be tested as per provisions of the Mandatory Tests in CPWD specifications and the relevant IS specifications. The Engineer may relax the condition regarding testing if the quantity of materials required for the work is small. Proper proof of procurement of materials from authentic manufacturers shall be provided by the contractor to the satisfaction of Engineer. Grade of cement used shall be OPC 43 Grade unless otherwise specified explicitly. The contractor shall get the Design Mix for concrete done by the labs approved by Engineer-in-charge. Reinforcement Steel used shall be of TMT Fe-500 D unless otherwise specified.

1.7 In respect of the work of the sub-agencies deployed for doing work of civil,electrification, air-conditioning, external services, other building work, horticulture work, etc. for this project and any other agencies simultaneously executing other works, the contractor shall afford necessary coordination and facilities for the same. The contractor shall leave such necessary holes, openings, etc. for laying / burrying in the work pipes, cables, conduits, clamps, boxes and hooks for fan clamps, etc. as may be required for the electric, sanitary, air-conditioning, fire fighting, telephone system, C.C.T.V. system, ducting,

1.8 Unless otherwise specified, the rates for all items of work shall be considered as inclusive of pumping out or bailing out water if required for which no extra payment will be made. This will include water encountered from any source such as rains, floods, or due to any other cause whatsoever

1.9 Any cement slurry added over base surface (or) for continuation of concreting for bond is added its cost is deemed to have in built in the scope.

1.10 The works in which the use of cement is involved is inclusive of curing.

1.11 The contractor shall clear the site thoroughly of all scaffolding materials and rubbish etc. left out of his work and dress the site around the building to the satisfaction of the Engineer-in-charge before the work is considered as complete.

1.12 The plastering work (excluding washed grit finish on external wall surfaces) shall include for making grooves, bands etc. wherever required and nothing extra shall be paid for the same.

1.13 The brick/concrete work shall be deemed to include making openings and making good these with the same specifications as shown in drawings and/or as directed. No extra payment shall be made to the contractor on this account.

1.14 The concrete/plaster work shall include for making drip course moulding, grooves etc. wherever required and nothing extra shall be paid for the same.

1.15 Flooring work shall include for laying the flooring in strips/as per sample or as shown in drawings wherever required and nothing extra shall be paid for the same.

1.16 The drawing(s) attached with the tender documents are for the purpose of tender only, giving the tenderer a general idea of the nature and the extent of works to be executed. The price quoted by the tenderer shall be deemed to be inclusive of all costs involved for the execution and completion of works in all respect essentially required to make the building and the facility functional, taking into account the design and detailing aspect involved for the works to be executed and completed in accordance with the relevant specifications, standards, BIS codes. The Structural drawings shall be proof checked from IIT/NIT/any other Govt. Institute, as approved by the Client. However, the accuracy and sufficiency of the construction drawings shall be re-checked and coordinated with other services by the contractor to ensure the correctness of drawings and any discrepancy shall be brought immediately to the notice of the Engineer-in-charge. Manufacturers or supplier specific shop drawings shall be submitted by the contractor for approval, before proceeding with work.

1.17 The quoted rate shall be for finished items and shall be complete in all respects including the cost of all materials, labour, tools & plants, machinery etc., all taxes, duties, levies, octroi, royalty charges, statutory levies etc. as applicable and any other item required but not mentioned elsewhere in the documents.

1.18 The client/executing agency shall not be supplying any material, labour, plant etc. unless explicitly mentioned so.

1.19 Stacking of materials and excavated earth including its disposal shall be done as per the directions of the Engineer-in-Charge. Double handling of materials or excavated earth if required shall have to be done by the contractor at his own cost.

•Clearing

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

•Site Levels

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

•Bench-marks

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

•Site investigation

The contractor shall inspect the site and study the findings from the trial pits or bores in order to assess the problems involved in and methods to be adopted for excavation and earthwork. The contractor shall ascertain for himself all information concerning the sub-soil conditions, Ground water table, periods and intensity of rainfall, flooding of the site and all data concerning excavation and earthwork. Any additional work incurred during execution due to insufficient investigations will not be paid extra.

•Setting out the work

The contractor shall do proper setting out for the building, any additional work executed due to improper setting out shall be borne by the contractor.

The contractor shall ensure compliance with all documents throughout the execution time.The contractor shall be responsible for all the errors in this connection and shall have to rectify all defects and/or errors at his own cost, failing which the EIC reserves the right to get the same rectified at the risk and cost of the contractor.

SITE DEVELOPMENT AND EARTH WORK

2.1General

This specification deals with the clearance of the Site of Works and preparation of the same to commence the proposed construction activities. Wherever applicable, this is deemed to include all preliminary works like, Site Clearance, General Levelling etc., at Contractor's cost.

The Contractor, at his own cost, shall visit the site, inspect the same and decide for himself the nature of the ground and the sub-soil to be excavated. No claim on account of extras will be entertained in consequences of any misunderstanding or incorrect information or ignorance of the existing conditions. The following specification but not limited to, shall be followed for site development and earth works.

EARTH WORK

Excavation shall be undertaken to the width of the Basement / Retaining wall footing including necessary margins for construction operation as per approved drawings or directed otherwise. Where the nature of soil or the depth of the trench and season of the year, do not permit vertical sides, the contractor at his own expense shall put up the necessary shoring, strutting and planking or cut slopes with or without steps, to a safer angle or both with due regard to the safety of personnel and works and to the satisfaction of the Engineer. All the major excavation shall be carried out by mechanical excavator. No extra payment shall be made for that.

The contractor shall make at his own cost all necessary arrangements for maintaining water level, in the area where works are low enough so as not to cause any harm to the works or problems in carrying out with the execution and the rates for all items of work shall be considered as inclusive of pumping out or bailing out water, if required, for which no extra payment shall be made. This will include water coming from any source, such as rains, accumulated rain water, floods, leakages from sewer and water mains subsoil water table being high or due to any other cause whatsoever. The contractor shall make necessary provision of pumping, dredging, bailing out water coming from all above sources and excavation and other works shall be kept free of water by providing a suitable system approved by the Engineer-in-charge.

The water level may vary due to rainy season or due to dewatering etc. In order to avoid possibility of basement floor of main building being getting uplifted/damaged due to water pressure, the contractor shall make arrangements for lowering the ground water table below the proposed foundation level as approved by Engineer-in-charge. Sub soil water table shall be maintained at least 50 cm below the P.C.C. level during laying of P.C.C., water proofing treatment, laying of basement raft and beams including filling of earth/sand under the basement floor. The water table shall not be allowed to rise above base of raft level until completion of outer retaining walls including water proofing of vertical surface of walls and back filling along the walls up to ground level and until the structure attains such height to counter balance the uplift pressure. However, the contractor should inspect the site and make his own assessment about sub-soil water level likely to be encountered at the time of execution and quote his rates accordingly. Rate of all items are inclusive of pumping out or bailing out water, if required. Nothing

extra on this account whatsoever shall be paid to him. The sequence of construction shall be got approved by the Engineer-in-charge.

2.2Anti-termite treatment

Anti-termite treatment shall be got done through approved specialized agencies only with prior approval of the Engineer-in-charge or his representative. During the execution of work,if any damage shall occur to the treatment already done ,either due to rain or any other circumstances, the same shall be rectified and made good to the entire satisfaction of the CLIENT/ HITES or his representative by the contractor at his costs and risks. The contractor shall submit a guarantee bond of ten years for the anti-termite work executed under the contract in the specified format.

Classification of Soils

The earth shall be classified under the following categories

2.3 Hard dense soil

Generally, any soil which requires the close application of picks or jumpers or scarifiers and rippers to loosen the same such as:

1. Stiff clay, hard shale or compact moorum requiring grafting tool and/or pick and shovel.
2. Shingle and river or nallah bed boulders.
3. Lime concrete, stone masonry in lime or cement mortar below ground level.
4. Soft, conglomerate or soft laterite when the stone can be detached from the matrix with picks and shovel.
5. Existing WBM roads, pavements etc.

2.4 Ordinary/Soft/Decomposed rock (not requiring blasting)

Rock or boulders, which may be quarried or split with crowbars or wedges/picks; such as lime stone, sand stone, hard laterite, hard conglomerate or other soft or disintegrated rock.

2.5 Hard rock (requiring blasting):

Rock which is in solid beds, which can only be removed either by wedging or chiselling, shall be treated as hard rock. An isolated boulder or detached rock, measuring one cubic meter or more, shall also be treated as hard rock, if the same cannot be removed without wedging or chiselling.

(If required, approved chemical may be used for loosening the materials).

Blasting is totally prohibited and will not be allowed under any circumstances.

2.6 Authority for classification of Soils/Rocks

The classification of excavation shall be decided by the EIC and his decision shall be final and binding on the contractor.

2.7 Blasting

Blasting shall not be permitted under any circumstances. The Contractor, at his own cost can use alternate chemicals to split rock with the approval if EIC. The contractor shall submit with his tender, the method which he intends to adopt for execution of the work of rock excavation. A list of specialised tools and plants to be used for rock excavation shall be enclosed.

2.8 Trimming of Slopes

All slopes shall be trimmed by hand or mechanically true to line and profile and consolidated to the EIC's satisfaction. Any rock or boulders appearing on the face or likely to be unstable, shall be removed and the void thereof filled with approved material and compacted. No extra amount shall be claimed by the contractor on this account and his quoted rates shall be deemed to have been included for trimming of slopes.

2.9 Shoring/Earth work support

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

2.10 Dewatering

All excavation shall be kept free from water from any source. The contractor shall provide and clear away on completion, all drains, pumps and other equipment, for this purpose. The

contractor shall be responsible for preventing any subsidence of adjoining ground due to pumping.

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

2.11 Contractor to keep excavation clear

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

2.12 Back filling

All materials used as fill shall be to the EIC's approval and shall be well consolidated in layers not more than 200 mm thick. Final compacting must be done just before concrete is to be laid.

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

Sand, soil, gravel etc. from the excavation may be used for backfilling of pits and trenches or for making up levels subject to approval of the EIC and subject to selection of proper materials. The contractor shall take instructions of the EIC regarding the location in which each type of excavated material is to be used according to its quality.

In case the excavated materials are not approved for backfilling, either totally or in part or if their quantity falls short of the quantity required for filling, suitable materials shall be brought to site from an approved source. No extra amount shall be claimed by the contractor on this account and his quoted rates shall be deemed to have been included for total backfilling.

2.13 Disposal of surplus

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

●Wherever rock excavation is encountered, contractor shall remove the same without any extra cost. The Contrcator shall visit the site and assess the site condition before quoting for the work.
●The unused excavated rubble to be disposed in line with all present roles and regulations of govt.

2.14 Excavation in all Soils

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

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

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

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

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

2.15. Sweet Earth

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

PLAIN AND REINFORCEMENT CEMENT CONCRETE WORKS

3.1 General

All concrete included in the works shall comply with the General requirements of this section of the specification except where those requirements are modified by the provisions of later Clauses relating to specialized uses for concrete in which case the requirements of those Clauses shall take precedence. All designs and execution shall be according to the latest version of relevant IS codes, CPWD and other relevant manuals mentioned elsewhere in this document. The following specification but not limited to,shall be followed for concrete and steel works.

3.2 CONCRETE WORKS (PLAIN AND RCC)

(i)Generally, all concrete work shall be as per IS-456 (latest edition) characteristic strength (28 days) shall be 20 N/sq. mm, 25 N/Sq mm, 30 N/Sq mm and 35N/sqmm as may be specified on drawings. The use of concrete admixtures shall be approved by the EIC. The items include for providing all materials, mixing, placing, compacting, cutting, finishing, placing inserts, holding down bolts and flanges, sleeves, puddle flanges, embedding all services pipes, boxes, hooks etc. as shown in drawings at correct location level with required changes in form work, reinforcement etc., complete. All RCC works and all concrete shall be machine vibrated. All concrete shall be with 20mm and down graded nominal size stone aggregates except specified otherwise. Curing of the concrete shall be as per IS-456 (Latest Edition).

(ii)The rate of reinforcement work shall include for handling/ storing clearing of rust, straightening, bending and placing, binding, fixing in proper position at any height/level with 18 gauge annealed binding wires, necessary chairs, spacer bars, wastage and cement mortar cover blocks at proper positions to maintain proper cover as per IS-456 (Latest Edition).

(iii)Inverted cantilever, Circular / Curved, offsets, Projection, fins, bands, nibs and sloping members on slab, beams, columns, staircase including drilling, cutting, bonding agent complete to the satisfaction of EIC etc.

(iv)Holes and openings in RCC slab/walls, parapet, masonry works, pockets in machine foundation, beam, parapets, for rainwater pipe or spouts and plumbing pipes shall be left at the time of concrete casting or raising masonry and making good after fixing fixtures.

(v)If in the opinion of the EIC, any surface other than specified for obtaining patterns in exposed surface in concrete under specific items, is asked to be left unrendered and painted, then the item will not be measured as item concerning exposed surface and no extra for any reason will be allowed.

(vi)Jointing new work with the existing concrete/brickwork including shuttering and approved bonding agent for construction joints.

(vii)Reinforcement shall be by weight actually placed in position as per the bar bending schedule, to be prepared by the contractor and approved by the EIC. The weight shall be taken as per IS Code for the particular diameter. Rates quoted for reinforcement shall include for cutting, bending, binding the reinforcement bars in any shape, hoisting to all leads and lifts and placing in any position as per detailed drawings, including providing precast cement concrete cover blocks of required thickness for keeping bars in position. 18 gauge annealed binding wire for tying for reinforcement shall be provided by the contractor. The contractor should cover for this in his overall rate for the reinforcement rates including removing rust, Mill scales, oil, grease, paint etc. from reinforcing bars.

(viii)Centring, shuttering, boxing propping including special nuts, bolts etc. in perfect line, level, plumb and if required to provide camber, slope and removal thereof. Colourless shuttering oil or grease of approved quality shall be applied to forms before placing steel. Rate to include for any shapes including offsets/ chamfering in columns, residues, grooves, drip moulds, irregular shapes etc. Stripping time for the formwork, centring and dropping shall be as per IS-456 (Latest Edition).

(ix)Work at all heights, depths & levels irrespective of individual storey.

(x)Work in narrow widths, Piece meal/ small work, screeding under floor etc.

(xi)All staging upto any height and scaffolding work shall comprise of MS Pipes/ Structural steel sections with necessary coupling arrangement. (NO WOODEN BALLIES / PROPS WILL BE PERMITTED). Adequate size foundation blocks / base plates shall be provide below staging members to disperse the loads as per the founding strata.

(xii)Contractor shall set up on site concrete pump, hoists, tower cranes, passenger elevator, automatic microchips controlled Batching plant of capacity 30 cum per hour or more (min. 2 nos.) complete with silos/ stock piles for cement and aggregates, and also a D.G. set to be provided for uninterrupted supply of concrete. Use of batching plant for all concrete work is mandatory.

(xiii)Providing grooves, drip moulds, moulds, chamfers, curved surfaces, and ornamental works in RCC members as per drawing and finishing to specified shape.

(xiv)Forming all expansion and / or construction joints as directed.

(xv)Contractor to consider in his quoted rates the necessary arrangement e.g. providing and fixing of required quantity of woven mesh at the junction of Beam and Column or any other RCC members to separate two different grade of concrete mixes. No payment shall be made for over flowed richer mix of one RCC member into the other.

(xvi)Use of greater than minimum specified quantities of cement to achieve specified or required mix design.

(xvii)RCC (M30) for all water retaining structures greater than 50 cubic metre as per IS 3370(Latest Edition).

(xviii)Use of plasticiser / super plasticiser (approved by EIC) and / or additional cement for pumpable concrete.

(xix)Non-destructive test for defective concrete as directed by EIC, and their remedial measures thereof if required.

(xx)Providing dowels for anchorage and joining RCC members if required.

(xxi)Mix designing and testing of all the ingredients of concrete from Indian Institute of Technology / other Institutions of National importance approved by HITES for each grade, pumpable & non-pumpable concrete.

(xxii)Compliance with all requirements of technical specification.

3.3 Quality Assurance Plans and Supervision:

A competent person shall be employed full time whose first duty will be to supervise all stages in the preparation and placing of the concrete. All test on materials, the making and testing of cubes and the maintenance and calibration of all mixing and measuring plant shall be carried out under his direct supervision in the presence of the EIC. Contractor shall set up a laboratory with all testing arrangement at site. On award of the work contractor shall submit their quality assurance plans, complete methodology & sequence of construction for all activities to EIC.

3.4 Materials

a) **Cement**

Cement shall in general comply the following specifications:

i) **Types**

The cement used shall be ordinary portland cement conforming to IS 8112 - 1989 (Latest revision) of grade 43/ IS 12269 - 2013 (Latest revision). PPC confirming to 1489 (Part I) - 1991 (Latest revision) shall be followed.

All cement shall be fresh when delivered. Cement shall be delivered in sound and properly secured bags or other packages ready for immediate use and shall be used direct from the bag. The contractor shall maintain for EIC' inspection a record of receipts and consumption of cement indicating the source, the age and the date of receipt of cement. Cement containing lumps which cannot be broken by a light touch of fingers shall not be used in the works. Admixtures shall not be used without written consent of the EIC.

ii) **Sources**

The contractor shall use the cement as required in the work, from manufacturers as per list of approved makes or from any other reputed cement manufacturer having a production capacity not less than one million tons per annum. Makes and sources of cement shall not be varied from those used for trial mixes; should a change be unavoidable the contractor shall submit his proposals for the prior approval of the EIC and then carry out new trial mixes unless otherwise directed by the EIC. Cement of different kinds shall not be mixed at any stage.

iii) **Manufacturers' Test Certificates for Cement**

The Contractor shall request the cement manufacturer to forward to his site office the Certificate of conformity in accordance with IS (Latest Revision), and he shall cause a copy to be supplied to the EIC within 48 hours of the arrival of the certificate, which shall not be later than 14 days from the day of delivery of the relevant consignment. The test certificate shall be related to the date of delivery at site of consignment. The frequency of deliveries shall be such as to ensure that no cement is more than 3 months old when used in the works.

iv) **Samples of Cement**

Samples of cement to be used in the works shall be deposited with the EIC for his approval together with a certificate stating the name and address of the Manufacturer, the name and address of the supplier from whom it was purchased. The EIC may from time to time take samples of the cement being used in the works for testing. The cement shall be got tested by the Engineer-in-charge and shall be used on the work only after satisfactory test results have been received. The Contractor shall supply free of charge the cement required for testing including its transportation cost to testing laboratories. The cost of tests shall be borne by the Contractor

v) **Storage of Cement**

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

Incase cement gets affected from damp or any other deleterious influence, such cement shall not be used for construction work. The damaged cement shall be removed from the site immediately by the Contractor on receipt of a notice in writing from the Engineer-in-charge. If he does not do so within 3 days of receipt of such notice, the Engineer-in-charge shall get it removed at the cost of the Contractor.

b) **Aggregates**

i) Materials used as aggregates shall be obtained from a source known to produce aggregates satisfactory for concrete and shall be chemically inert, strong, hard, durable, of limited porosity and free from adherings, coating, clay lumps, coal residues and organic or other impurities that

may cause corrosion of reinforcement or may impair the strength or durability of the concrete. Aggregates shall be tested in accordance with the requirements of IS. 383 or IS. 515 and the results of such tests shall be as hereinafter specified, the percentages being by weight unless the context indicates otherwise.

ii) Fine aggregates shall be natural sand or sand derived by crushing material like gravel or stone and shall be free from coagulated lumps. Sand derived from stone unsuitable for coarse aggregates shall not be used as fine aggregates. The caustic soda test for organic impurities shall show a colour not deeper than that of the Standard solution. The amount of fine particles as ascertained by the Laboratory Sedimentation test shall not exceed 10% for crushed stones. The settling test for natural sand or crushed stone shall be made, and after being allowed to set in for three hours the thickness of the layer of silt deposited on the coarser material shall not exceed 8%.

The grading of a natural sand or crushed stone i.e. fine aggregates shall be such that not more than 5 (five) percent shall exceed 5 mm in size, not more than 10% shall pass IS sieve No. 150 not less than 45% or more than 85% shall pass IS sieve No. 1.18 mm and not less than 25% or more than 60% shall pass IS Sieve No. 600 micron.

Only washed sand of quality and grading specified herein above shall be used. Admixture of sand obtained by crushing natural stone may be permitted by the EIC, provided the mixture satisfies the requirements for the fine aggregates here in above specified. But not more than one part of the sand obtained by crushing natural stone may be added to two parts of washed sand.

iii) **Coarse Aggregate**

Coarse Aggregates shall be crushed stone. The pieces shall be angular, rounded in shape and shall have granular or crystalline or smooth (but not glossy) non-powdery surface. Fragile, flaky and laminated pieces, and mica shall not be present.

The "Aggregates Crushing Value" shall not exceed 45%. The amount of fine particles occurring in a free state or as a loose adherent shall not exceed 1%. When determined by the laboratory sedimentation test, after twenty four hours immersion in water. A previously dried sample of the coarse aggregates shall not have gained in weight more than 5%.

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

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

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

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

Aggregate (Fine and Coarse) shall be thoroughly washed with clean water if so directed by the EIC.

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

The Contractor shall procure reinforcement steel from primary steel producers from the list of Approved make for Civil Works provided in the agreement. The manufacturer has to give a certificate that the material supplied is not a re-rolled product. Relevant vouchers & test certificates will be produced by the contractor. The Contractor shall have to obtain and furnish manufacturer Test Report /test certificates for each lot. Tests to the Engineer-in-charge in respect of all supplies of steel brought by him to the site of work. Re-rolled sections will not be allowed. Reinforcement steel, structural steel shall be stored and stacked in such manner so as to facilitate easy identification, removal etc. The contractor shall take proper care to prevent direct contact between the steel and the ground/ water for which he shall provide necessary arrangement at his own cost including ensuring proper drainage of area to prevent water logging as per direction of the Engineer-in- charge. Steel shall also be protected, by applying a coat of neat cement slurry over the bars for which no extra payment shall be made. Test certificates for each consignment of steel shall be furnished and further tests shall be got carried out from the authorized laboratory as per the directions of Engineer-in-charge, before incorporating the materials in the work. Nothing extra will be paid for “straightening of bars” received from market in coils or with bends. All

incidental charges of any kind whatsoever including cartage, storage, safe custody of materials, cutting and wastage etc. shall be borne by the contractor.

The reinforcement steel shall in general comply the following specifications:

(i)**Type**

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

(ii)**Storage of Reinforcement**

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

(iii)**Fabrication**

Fabrication shall be accurately done to the dimensions, spacing and minimum cover as per structural drawings. Spacers shall be of cement mortar (1:2) cubes however shall not be leaner than the approved design mix. Steel chairs, spacer bars shall be used in order to ensure accurate positioning of reinforcement. All joints in steel reinforcement shall be overlapped.

(iv)**Welded Laps**

Wherever specified, welded laps shall be provided and paid for separately unless specifically included in the item of work. No payment shall be made to the contractor for welding as per EIC's requirements, if the same is necessitated due to the reasons attributable to the Contractor. The welding of bars shall be carried out as per IS: 2751-1979, IS:9417-1979. Before doing welding of bars at site, the contractor shall make minimum 3 joints and get them tested in an approved laboratory at his own cost. The following precautions shall be taken:

a) If the cold twisted deformed bar has an untwisted end at lapping point, then this portion shall be cut off prior to welding.

b) Bars shall be free from rust at joints to be welded.
c)Bars shall be aligned and kept in proper axis in order to minimize crookedness in bar after welding.

The Contractor shall supply free of cost the required steel bars for testing as per the requirement. The cost of tests shall be borne by the Contractor. In case the test results indicate that the steel arranged by the Contractor does not conform to the specifications as defined the same shall stand rejected, and it shall be removed from the site of work by the Contractor at his cost within a week time or written orders from the Engineer-in-Charge to do so. For checking nominal mass, tensile strength, bend test & re-bend test etc. specimen of sufficient length shall be cut from each size of the bar at random at frequency not less than the specified below:

Size of bar	**For consignment below 100 tones**	**For consignment above 100 tonnes**
Under 10 mm dia bars	One sample for each 25 tonnes or part thereof	One sample for each 40 tonnes part thereof
10 mm to 16mm dia bars	One sample for each 35 tonnes or part thereof	One sample for each 45 tonnes part thereof
Over 16mm dia bars	One sample for each 45 tonnes or part thereof	One sample for each 50 tonnes part thereof

The actual issue and consumption of steel on work shall be regulated and proper accounts shall be maintained. The theoretical consumption of steel shall be worked out as per procedure prescribed in GCC and shall be governed by conditions laid therein.

Steel brought to site and remaining unused shall not be removed from site without the written permission of Engineer-in-Charge.

Bar Bending Schedule: - Contractor shall prepare bar bending schedules and shall get them approved from the Engineer-in-charge or his authorized representative.

Records of Consumption of Cement & Steel:
a)For the purpose of keeping a record of cement and steel received at site and consumed in works, the contractor shall maintain a properly bound register in the form approved by the Engineer-in-charge, showing columns like quantity received and used in work and balance in hand etc. The contractor‘s representative shall sign this register daily.
b)The register of cement & steel shall be kept at site in the safe custody of Engineer-in-charge during progress of the work. This work. This provision will not, however, absolve the contractor from the quality of the final product.

Water

Type

Water for mixing concrete shall be clean and free from harmful material and comply with the requirements of Clause 5.4 of IS:456:latest.

Water shall be only from sources / bore wells approved by the EIC, and shall be used in a manner as directed by the EIC.

Testing of Water

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

3.5. Grades and Strength Requirements of Concrete

General

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

Slump

Only specified quantity of water shall be added to the cement and aggregate during mixing to produce concrete having a sufficient workability to enable it to be well consolidated, to be worked in to the corners of the shuttering and around the reinforcement to give the specified surface finish, and to have the specified strength. Water cement ratio shall be maintained as per IS. 456-(latest) unless specified otherwise.

Incase of pumpable concrete the slump & workability required for pumping the concrete shall be achieved by the contractor at his own cost. Nothing extra shall be paid for use of extra cement and / or plasticisers.

Concrete Grades

Grade of concrete used in the works shall be shown on the drawings or as directed by the EIC. Minimum cement contents shall be as per Is 456- (latest) or specified otherwise. The grade of concrete to be adopted in the construction shall be as follows:-

a) For mud mat, lean concrete , mass filling the concrete mix will be nominal mix concrete of 1:5:10 , 1:4:8 , 1: 3:6 (Cement : Coarse sand : 20mm Down aggregates) grade as specified in the construction drawings These mixes may be prepared using mechanical mixer.

a)For all RC.C work concrete used will be controlled concrete with grade of concrete M20 or more as per construction drawings. The cementitious contents in the mix design shall not be lesser than as indicated in the table below. The water cement ratio and other parameters shall be strictly adhered to as per the table below:

Grade	Min. cement	Water Cement

	Kg/ Cum.	Kg/Cum.(*) ratio
M - 20	300	0.55
M - 25	300	0.5
M - 30	320	0.45
M - 35	340	0.45
M- 40	360	0.40

*Note:- the actual requirements of cement contents are likely to be more than the minimum indicated. The limit has been fixed strictly from the concrete's durability point of view.

Approved admixtures may be used strictly as per IS 456-(latest) and nothing extra will be paid for the use of the same. Admixture used should not impair durability of concrete nor combine with constituents to form harmful compounds nor increase the risk of corrosion of reinforcement. Dosages of retarders, plasticisers and supertplasticisers if used shall not exceed 0.5, 1.0 and 2.0 percent respectively by weight of cementitious materials.

3.6 MIX DESIGN

The RCC work shall be done with RMC of Design Mix Concrete, unless otherwise specified. The contractor shall carry out design mixes for each class of concrete indicating that the concrete ingredients and proportions will result in concrete mix meeting requirements specified.

As the guarantor of quality of concrete used in the construction, contractor shall carryout mix design and the mix so designed shall be approved by the EIC, however approval by EIC shall not relive the contractor from his responsibility towards quality & sufficiency of design mixes. The mix shall be designed to produce the grade of concrete having workability and a characteristic strength as indicated in the drawings. The target mean strength of concrete mix should be equal to the characteristic strength plus 1.65 times the standard deviation as indicted below.

GRADE OF CONCRETE STANDARD DEVIATION (N/Sq mm)

M10, M15	3.5
M20, M25	4.0
M30 to M50	5.0

Mix design shall be carried out as per SP-23 (Hand book concrete mixes) Proportion / Type of aggregates shall be made by trial in such a way so as to obtain dense possible concrete with required workability. All ingredients of concrete should be used by mass only. Contractor shall carry out the mix design and get it tested from the laboratory / Institution as per the instructions of EIC

No substitutions in materials used on the work or alterations in the established proportions be made without additional test to show that the quality and strength of concrete are satisfactory. Design mix shall not be converted into volume mix under any circumstances.

The EIC will reserve the right to inspect at any stage and reject the concrete if he is not satisfied about quality of product at the user‘s end.

The EIC reserves the right to exercise control over the: -

a. Ingredients, water and admixtures purchased, stored and to be used in the concrete including conducting of tests for checking quality of materials, recording of test results and declaring the materials fit or unfit for use in production of mix.

b. Calibration check of the plant.

c. Weight and quantity check on the ingredients, water and admixtures added for batch mixing.

d. Time of mixing of concrete.

e. Testing of fresh concrete, recordings of results and declaring the mix fit or unfit for use. This will include continuous control on the workability during production and taking corrective action, if required.

For exercising such control, the EIC shall periodically depute his authorized representative at the RMC plant. It shall be responsibility of the Contractor to ensure that all necessary equipment, manpower & facilities are made available to EIC and/or his authorized representative at RMC plant.

All required relevant records of produced and used concrete shall be made available to the EIC or his authorized representative. EIC shall, as required, specify guidelines & additional procedures for quality control & other parameters in respect of materials, production & transportation of concrete mix which shall be binding on the Contractor. Only concrete as approved in design mix by Engineer-in-Charge shall be produced and transported to the site.

3.7 Ready Mix Concrete (RMC):

i. The contractor shall engage Ready Mix Concrete (RMC) producing plants (Distance of plant from site to be approved by Engineer in Charge) to supply RMC for the work. The RMC plant proposed to be engaged by the contractor shall fulfill the following requirements.

a) It shall be fully computerized.

b) It should have supplied RMC for Govt. projects.

c) It should have facility for providing printed advice showing ingredients of concrete carried by each mixer.

ii. The Ready Mix Concrete (RMC) producing plants of the main Cement producers shall be preferred.

iii. The contractor shall, within 30 days of award of the work submit list of at least three reputed RMC plant companies along with details of such plants Including details of transit mixer, pumps etc. to be deployed indicating name of Company, its location, capacity, technical establishment, past experience for approval by Engineer-in-charge.

iv. The Engineer-in-Charge reserves the right to exercise check over the:-

a) Ingredients, water and admixtures purchased, stored and to be used in the concrete including conducting of tests for checking quality of materials recordings of test results and declaring the material fit or unfit for use in production of mix.

b) Calibration check of the RMC.

c) Weight and quality check on the ingredient, water and admixture added for batch mixing.

d) Time of mixing of concrete.

e) Testing of fresh concrete, recordings of results and declaring the mix fit or unfit for use. This will include continuous control on the workability during production and taking corrective action.

For exercising such control, the Engineer shall periodically depute his authorized representative at the RMC plant. It shall be the responsibility of the contractor to ensure that the necessary

equipment manpower & facilities are made available to Engineer and/or his authorized representative at RMC plant.

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

vi. All required relevant records of RMC shall be made available to the Engineer or his authorized representative. Engineer shall, as required, specify guidelines & additional procedures for quality control & other parameters in respect of materials, production and transportation of concrete mix which shall be binding on the contractor & the RMC plant.

vii. It shall be the responsibility of the Contractor to ensure that the RMC producer provides all necessary testing equipment and takes all necessary measures to ensure Quality control of ready -mixed concrete. In general the required measures shall be:-

●Control of Purchased Material Quality:

RMC producer shall ensure that the materials purchased and used in the production of concrete conform to the stipulation of the relevant agreed standards with the material Supplier and the requirement of the product mix design and quality control producer‘s. This shall be accomplished by visual checks, sampling and testing, certification from materials suppliers and information /data from material supplier. Necessary equipment for the testing of all material shall be provided and maintained in calibration condition at the plant by the RMC producer.

●Control of Material Storage:

Adequate and effective storage arrangement shall be provided by RMC producer at RMC plant for prevention of contamination, reliable transfer and feed system, drainage of aggregates, prevention of freeing or excessive solar heating of Aggregate etc.,

●Record of Mix Design and Mix Design Modification:

RMC producer shall ensure that record of mix design and mix design modification is available in his computer at RMC plant for inspection of Engineer or his representative at any time.

●Computer Print outs of Each Truck Load:

Each truckload / transit mixer dispatched to site shall carry computer printout of the ingredients of the concrete it is carrying. The printout shall be produced to Engineer or his representative at site before RMC issued in work.

●Transfer and Weighing Equipment:

RMC Producer shall ensure that a documented calibration is in place. Proper calibration records shall be made available indicating date of next calibration due, corrective action taken etc. RMC producer shall ensure additional calibration checks whenever required by the Engineer in writing to contractor. RMC producer shall also maintain a daily production record including details of mixes supplied. Record shall be maintained of what materials were used for that day‘s production including water and admixtures.

●Maintenance of Plant, Truck Mixers and Pumps:

Plant, Truck Mixers and Pumps should be well maintained so that it does not hamper any operation of production, transportation and placement.

●Production of Concrete:

The following precautions shall be taken during the production of RMC at the plant

a) Weighing (correct reading of batch data and accurate weighing):- For each load, written, printed or graphical records shall be made of the weights of the materials batched, the estimated slump, the total amount of water added to load the delivery tickets number for that load and the time of loading the concrete into the truck.

b) Visual observation of concrete during production and delivery or during sampling and testing of fresh concrete assessment of uniformity, cohesion, workability adjustment to water content. The workability of the concrete shall be controlled on a continuous basis during production. The batch mix found unfit shall not be loaded into the truck for transportation. Necessary corrective action shall be taken in the production of mix as required for further batches.

c) Use of adequate equipment at the plant to measure surface moisture content of aggregates, particularly fine aggregates or the workability of the concrete, cube tests etc. shall also be ensured.

d) Making corresponding adjustment at the plant automatically or manually to batched quantities to allow for observed, measured or reported changes in materials or concrete qualities.

e) Sampling of concrete, testing monitoring of results.

f)Diagnosis and correction of faults identified from observations / complaints

●The RMC plant produced concrete shall be accepted by EIC at site after receipt of the same after fulfilling all the requirements of mix mentioned in the tender documents.

a) The Item of design mix cement concrete is inclusive of all the ingredients including admixtures, if required, labour, machinery T&P etc. required for a design mix concrete of required strength and workability, and, shall take into account change, if any, in quantities of concrete, ingredients like cement and aggregates and admixtures etc. as per the approved mix design.

b) Ready mix concrete shall be arranged in quantity as required at site of work. The ready mix concrete shall be supplied as per the pre-agreed schedule approved by Engineer.

c) Frequency of sampling and standards of acceptance shall be as per CPWD specifications.

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

e) The RMC shall be placed by pump of suitable capacity and the arrangements shall be made to arrange sufficient length of pipe at site to place the RMC in the minimum required time.

f) Pre delivery tickets shall be produced with each truck load of RMC.

g) The representative of RMC supplier shall attend the site meetings as and when decided by the EIC

h) The contractor shall assess the quantity of RMC requirement at site well in advance and order accordingly to the RMC supplier. It shall be the responsibility of the contractor to arrage requisite quantity of RMC available at site, so that there is no hindrance to the work on this account.

3.8 Batching and Mixing

Only controlled design mix will be used for concrete with strength more or equal to M20. Volume batching may be allowed (Using mechanical Mixers) for mixes up to M10, for these leaner mixes mass volume relationship shall be checked frequently to ensure specified grading is maintained.

For the production of controlled concrete contractor shall set up, on site, automatic microchip controlled batching plant of capacity 30Cum/Hr or more minimum 2 nos. as per the requirement, complete with silos / stock piles for cement and aggregates and D.G sets to be provided to have uninterrupted supply of concrete. The batching plant shall be tested and calibrated as per manufacturers manual and to the satisfaction of EIC, before starting the production of concrete, to provide uniform & consistent cement concrete mix conforming to approved mix design Batching / Mixing plant shall conform to the requirements of IS 4925 & 4926. Batching plant shall have facilities for presetting the quantities to be weighed with automatic cut off when the same is achieved and also shall be equipped with sensors to control water ratio as per moisture contents of aggregates. Printed reports of all the components of all the batches of concrete as separated by on line computer of batching plant, shall be presented to EIC for his approval and records. Cube samples from each batch shall be taken as per the requirement of IS 456-(latest), in the presence of EIC. Cubes shall be tested to record 7days & 28Days cube strength. Contractor shall be responsible for the quality of concrete which will be indicated as per the cube strength results at the end of 7days & 28days. However 28days strength results will be treated as final.

Contractor shall make his own trial mixes for different grade and submit the report of the final design mix to be adopted for different grades to EIC for his approval and records (Contractor shall take in cognisance while designing concrete mixes, time required for transporting and placing the cement concrete mix at final position). Contractor shall specify along its bid the type and make of the proposed batching plant with brief specifications. All the concrete shall be pumpable including column & wall. Contractor to make provision for adequate no. of pumps as required for horizontal & vertical concreting.

The accuracy of the measuring equipment should be within plus or minus 2% of the quantity of cement being measured and within plus or minus 3% of the quantity of aggregate, water , admixture being measured. All measuring equipment should be maintained in a clean, serviceable condition.

Mixing with mechanical mixer (for M20 or richer) will only be permitted in exceptional circumstances and then with the specific arrangement of the EIC. No water shall be added to mixed concrete other than the quantity of water allowed for in the mix design and incorporated in batching.

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

3.9 Concrete Admixtures &Plastisizers

Admixtures are materials added to the concrete before or during mixing with a view to modify one or more properties of concrete in plastic or hardened state. Concrete admixtures are proprietary items of manufacturers and shall be obtained from established manufacturers having proven track record, with EIC's approval.

3.8(a)Water proofing compound to be added to the concrete of buried, water retained structures, retaining wall etc as directed by the EIC

3.10 Transporting Concrete

From batching plant concrete to the location of proposed construction shall be transported through transit mixers or concrete pumps only. Contractor shall specify the make & type and number of transit mixers to be deployed along with concrete pumps with their make, capacity. The path to be used by transit mixers will be strictly as per the instructions of EIC. From the transit mixers concrete shall be transported to the final floor level / position through pumping only .Concrete

and mortar shall be transported speedily and deposited in its place in the works without contamination, loss of ingredients or segregation. Buckets of builders hoist shall be large enough to contain an integral number of batches .No concrete shall be placed in the works until the contractors' proposed method of transporting concrete have been approved.

3.11 Concrete placement

General

Concrete, when deposited, shall have a temperature of not less than $5^{o}C$ ($41^{o}F$) and not more than $32^{o}C$ ($90^{o}F$).

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

Contractor shall give adequate notice to the EIC of his intention to concrete any section of the works.

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

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

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

Placing concrete in cold weather

No concrete shall be mixed or placed while the ambient temperature is above 40 degree C. on a rising thermometer or below 5 degree C. on a falling thermometer. The contractor shall supply an accurate maximum and minimum thermometer and hang it in an approved position on the works. Aggregates that have been exposed to frost shall not be used until completely thawed. Concrete shall be maintained by approved means at a temperature of not less than 4 degree C. during placing, and for a period of three days thereafter. All concrete placed during cold weather or when a frost is predicated or is likely to occur or occurs contrary to expectation, shall be protected from freezing by approved means.

Placing of concrete in wet weather

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

Concrete placement under water

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

The construction of and the method of handling the tremmie pipes shall be approved by the EIC. The pipes shall be waterproof and sufficiently strong to withstand severe handling conditions and any joints must be sealed with adequate gaskets.

At the commencement of tremmie work the bottom of the pipe shall be sealed before being lowered in to position. The seal shall only be broken by the concrete being placed. The concrete placed in contact with a horizontal construction joint shall have a lower proportion of coarse aggregate and a higher proportion of cement than the remainder of the concrete. The proportion shall be agreed with the EIC's Representative.

All underwater concrete shall be placed in still water within a cofferdam or formwork which shall extend above water level.

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

3.12 Maintenance of Plant and Equipment

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

3.13 Night Work

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

3.14 Compacting Concrete

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

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

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

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

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

3.15 Quality Control

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

i)As frequently as the EIC's representative may require and in any case at least once a day while concreting is in progress, the contractor shall sample and carry out a determination of the moisture content and a mechanical analysis of the fine aggregate and each nominal size of coarse aggregate shall lie within the respective limits specified.

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

iv) Samples of concrete shall be taken at random in accordance with IS: 516 at the time and place of deposition of the concrete.

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

vi) Compliance with the specified characteristic strength shall be assumed if :

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

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

vii) No loading or free fall is permitted over concrete structures during curing period. Free fall of materials to concrete structures is also not allowed

3.16 Seven-day cube tests

Acceptance of concrete is based on the 28th day results. However, the contractor shall establish a relation ship between 7 days and 28 days strengths by carrying out 7 days tests at the time of performing the laboratory testing and from subsequent quality control testing. This relation ship shall be used in interpreting any further test results to predict the probable value of the corresponding 28 days cube strengths. The contractor shall without delay advise the EIC of any sample that appears likely to fail to meet the specification and the contractor shall take any necessary action to minimize the effect of such failure.

3.17 Acceptance Criteria

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

If any of the works tests are not up to the standard, the EIC shall have the power to stop the work until the reason is investigated and steps taken to prevent further low results. The contractor shall not be entitled to any claims on account of such delays. Any concrete carried out from the batch that is afterwards found to be faulty, will be liable for rejection and if so directed, the contractor shall at his own expenses dismantle and replace the defective work and any work built thereon or shall take such other measures as may be deemed necessary by the EIC. At the discretion of the

EIC, the contractor may be allowed to prove by means of a load test to be carried out at his own expense, that the concrete is capable of safely withstanding the loads as specified in the test.

3.18 Construction joints

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

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

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

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

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

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

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

3.19 Form Work and scaffolding / Staging :-

Form work to the fresh concrete shall be sufficiently rigid and shall be such as to prevent loss of slurry from the concrete and details and design of the form work shall conform to IS 14687. The tolerances on the shape, lines and dimensions shall be as per CL. 11 of IS 456 –2000.

All staging and scaffolding work shall comprise of MS .Pipes / Structural steel sections with necessary coupling arrangement. (NO WOODEN BALLIES / PROPS WILL BE PERMITTED) . Adequate size foundation blocks / base plates shall be provide below staging members to disperse the loads as per the founding strata.

Form work construction

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

ii) Form work shall be so constructed that concrete can be properly placed and thoroughly compacted. Form work shall be firmly supported and adequately strutted, braced or tied to maintain position and size. Forms shall have sufficient strength and rigidity to with stand the weight of wet concrete and necessary pressure due to ramming and vibration of concrete and movement of men material and other loads without excessive deflection from prescribed limits. It shall be capable of adjustment to the lines , levels and dimensions of the finished concrete.

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

iv) Beams boxes shall be erected with an upward camber of 6 mm for each 3 M. of span.

ii)Around the periphery of the building beyond building line, staging shall be erected by the contractor free of cost, using structural steel members duly braced to sustain all loads , with all safety measures like netting , temporary railings / parapets , platforms etc. to provide free access to external façade of the building at each floor level for construction and inspection. . Staging shall grow along with the building.

iii)Two full set of shuttering materials for each building to be made availbe at site

Removal of Form work(Striking Time)

Unless certainly specified in the drawing, or directed by the EIC, the following shall be minimum intervals of time, which should be allowed between the placing of the concrete and the striking of the mould where ordinary portland cement is used and ambient temperature does not fall below 15 degree Celsius.

a)	Walls, column & vertical faces of all structural members	16 to 24 hours as may be decided by the EIC.
b)	Slab	
i)	Spanning upto 4.50 m	7 days
ii)	Spanning over 4.50 M	14 days

Note: Soffit forms of the slab not to be removed after 3 days ,

c)	Beams and arches	
i)	Spanning upto 6 M	14 days
ii)	Spanning 6 M to 9 M	21 days
iii)	Spanning over 9 M	28 days

Note:

1. For other types of cement, the stripping time recommended for ordinary portland cement may be suitably modified. Forms shall not be released until the concrete has achieved a strength of at least twice the stress to which concrete may be subjected to after removal of the form.

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

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

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

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

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

Proposals for form work

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

No form work shall be constructed until the Contractors' proposals have been received and approved by the EIC.

Type of form work

Two qualities of form work shall be used i.eRough form work and wrought form work, as noted on the EIC's drawings or described hereafter.

Rough form work may be constructed of sawn timber or other material as agreed by the EIC. The edges of the boards shall be planned or otherwise rendered grout tight. Provided it remain grout tight, rough formwork may be used any number of time. This form work shall be adopted for surfaces not exposed/buried needing no surface finish viz. Foundations/Pile caps.

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

3.20 Surfaces of concrete

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

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

3.21 Tolerances in concrete surfaces

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

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

3.23 Curing

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

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

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

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

Alternatively, curing compound of approved make & as per manufacturer be used.

3.24 Examinations and Repairs

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

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

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

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

3.25 Fair face finish to concrete surfaces

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

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

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

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

3.26 Reinforcement Fabrication

Bending Schedules

The Contractor shall submit to the EIC, for the EIC's approval, bending schedule for all the works, not less than Ten days before the contractor intends to bend the reinforcing steel.

The Approval of the EIC shall in no way absolve the contractor of his responsibilities under the Contract.

Programme of reinforcement details required

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

Bending and placing reinforcement

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

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

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

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

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

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

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

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

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

Protection of reinforcement and concrete

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

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

Cover/Spacer Block

The contractor shall provide approved type of support for maintaining the bars in position and ensuring required spacing and correct cover of concrete to reinforcement as called for in the drawings, spacer blocks of required shape and size. Chairs and spacer bars shall be used in order to ensure accurate positioning of reinforcement. Spacer blocks shall be cast well in advance with approved proprietary pre-packed free flowing mortars of high early strength and same colour as surrounding concrete, Pre-cast cement mortar/concrete blocks/blocks of polymer shall not be used as spacer blocks unless specially approved by the EIC.

3.27 Precast concrete units

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

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

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

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

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

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

4. Masonry Works

Masonry work shall be carried out in conformity of Latest CPWD Specifications forworks.

Guide lines for chases is masonry walls as per Indian Standard BIS : 1905 need to be followed. The cutting of chases, recesses etc. should be done with out damage to the surrounding masonry. It is desirable to use such tools for cutting which depend upon rotary motion not on heavy impact for cutting action.

4.1 Solid Block Work

Precast Cement Concrete blocks shall be procured from approved manufactures or manufactured at site. Nothing extra shall be payable on account of adding any admixture for making precast blocks or for steam curing. • The Solid CC blocks shall have nominal size of 400mm x 200mm x 200mm or 300mmx200mmx200 for 200mm thick masonry wall& Solid blocks of nominal size 400mm x 200mm x 100mm or 300x200x100 for 100mm thick masonry wall and 400x200x150mm /300x200x150mm for 150 mm thick wallsshall confirm to IS2185part I of 1979. • The samples of CC blocks (each sample consisting of 6 specimens) shall be chosen randomly from the lot and tested for various parameters specified below. One samples shall be tested for every 100 cum or part thereof.

• Following parameters shall be tested.

a) Compressive strength.

b) Water absorption

c) Density

d) Dimensional Tolerances The material shall meet following parameters :

a) Compressive strength shall be no less than 5.0 N/sq. mm.

b) Water absorption shall not be more than 5%. c) Density shall be not less than 1500 kg/cum.

d) Dimensional tolerance in the size shall be not more than + 5mm for length and + 3mm for height and width.

Top course of all plinth, parapets, steps and top of walls below floor and roofs shall be laid with solid blocks, properly radiated and keyed into position to form cut corner. Where blocks cannot be cut to form cut corners, cement concrete 1:2:4 (1 cement : 2 coarse sand : 4 graded stone aggregate 20 mm nominal size) equal to thickness of the coarse shall be provided in lieu of cut blocks. No additional payment shall be made on this account. Nothing extra shall be payable on account of chasing the CC block masonry work for embedding pipes, electrical boards/ boxes etc. and also filling the chases with cement mortar 1:4 (1 Cement : 4 Coarse sand). The chasing shall however be carried out using machine cutters so as not to disturb the joints in the masonry and without any cracks being developed in the masonry. All other specifications for 100 mm thick and

200mm thick hollow/solid block work shall be as described for full brick and half brick masonry work respectively. For unsupported lengths of 100 mm thick walls exceeding 3.5 m, 100 x 200 mm wide R.C. mullions shall be provided at 3.5 m centre, tied to the lintels at door height. Similarly, continuous R.C. beam of size 100 x 150 mm shall be provided at door height for 100 mm thick wall.

4.2 BRICKWORK:

i) The bricks shall conform to the IS No. 1077-1986 of minimum crushing strength of 75 Kg./cm^2. (First Class)

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

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

iv) Every brick shall be thoroughly soaked in water before use. Broken bricks shall not be used except as closers. The courses shall be truly horizontal and the work strictly plumb, joints shall be broken vertically and they shall not exceed 12mm in thickness. All joints in brick work are to be well filled with mortar.

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

vi) All joints in brick work on both the faces shall be raked out 6mm deep as the work proceeds, and before the mortar sets.

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

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

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

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

xi)**Half brick masonry**: All brick work under 115 mm thick shall be reinforced with one no. 16 gauge 25mm wide MS flat in every fourth coarse. The said flat shall be cast in or securely fixed to adjoining concrete walls or columns by screw with fastener. No extra for the cost of MS flat will be paid.

xii)**Wall under structural members-** Allowance shall be made for leaving, temporarily open courses immediately below all structural members built into the walls. The open courses shall be left to permit full deflection of structural members. The open courses shall then be made good and pointed up after the structural members have been fully loaded and before the completion of the work.

4.3. Stone Masonry

Materials for stone masonry work:

Stone: The stone shallbe of the type specified such as Pink quartzite, granite, trap, limestone, sand stone, etc. and shall be obtained from the quarries, approved by the Project Manager. Stone shall be hard, sound, durable and free from weathering decay and defects like cavities, cracks,

flaws, sand holes, injurious veins, patches of loose or soft materials and other similar defects that may adversely affect its strength and appearance. As far as possible stones shall be of uniform colour, quality or texture. Generally stone shall not contain crypst crystalline silica or chart, mica and other deleterious materials like iron-oxide organic impurities etc.

Stones with round surface shall not be used.

The compressive strength of common types of stones shall be as per Table 1 and the percentage of water absorption shall generally not exceed 5% for stones other than specified in Table. For laterite this percentage is 12%.

Type of Stone	**Max. Water absorption % age by weight**	**Minimum. Compressive strength kg/sqcm.**
Granite	0.5	100
Basalt	0.5	400
Lime Stone (Slab& Tiles)	0.15	200
Sand Stone (Slab& Tiles)	2.5	300
Marble	0.40	500
Quartzite	0.40	800
Laterite (Block)	12	35

a) **Size of Stones :**Normally stones used should be small enough to be lifted and placed by hand. Unless otherwise indicated, the length of stones for stone masonry shall not

exceed three times the height/ breadth/ base of the stone and shall not be greater than three-fourth the thickness of wall, or not less than 15cm. The height of stone may be upto 30 cm or as decided by Project Manager.

b) Random Rubble Masonry shall be un-coursed or brought to courses as specified. Un-coursed random rubble masonry shall be constructed with stone of sizes as referred in above para and shapes picked up random from the stones brought from the approved quarry. Stones having sharp corners or round surfaces shall, however, not be used.

c) Random Rubble Masonry brought to the course is similar to uncoursed random rubble masonry except that the courses are roughly levelled at intervals varying from 30cm to 90cm in height according to the size of stones used.

d) **Dressing:** Each stone shall be hammer dressed on the face, the sides and the bed. Hammer dressing shall enable the stones to be laid close to neighbouring stones such that the bushing in the face shall not project more than 10mm on both the exposed faces.

Mortar: The mortar used for joining shall be as specified.

Laying: All stones shall be wetted before use. Each stone shall be placed close to the stones already laid so that the thickness of the mortar joints at the face is not more than 20mm. Face stones shall be arranged suitably to stagger the vertical joints and long vertical joints shall be avoided. Stones for hearting or interior filling shall be hammered down with wooden mallet into the position firmly bedded in mortar. Chips or sprawls of stones may be used for filing of interstices between the adjacent stones in heartening and these shall not exceed 20% of the quantity of stone masonry. To form a bond between successive courses plum stones projecting vertically by about 15 to 20 cm shall be firmly embedded in the heartening at the interval of about one metre in every course. No hollow space shall be left any where in the masonry.

The masonry work in wall shall be carried up true to plumb or to specified batter.

Random rubble masonry shall be brought to the level courses at plinth, window sills, lintel and roof levels. Levelling shall be done with concrete comprising of one part of the mortar as used of masonry and two parts of graded stone aggregate of 20mm nominal size.

The masonry in structure shall be carried uniformly. Where the masonry of one part is to be delayed, the work shall be raked back at an angle not steeper than 45 degree.

Bond Stones : Bond or through stones running right through the thickness of walls, shall be provided in walls upto 60cm thick and in case of walls above 60cm thickness, a set of two or more bond stones overlapping each other by at-least 15cm shall be provided in a line from face of the wall to the back.

In case of highly absorbent types of stones (porous lime stone and sand stone etc.) single piece bond stone may give rise to dampness. For all thicknesses of such walls, a set of two or more bond stones overlapping each other by at least 15cm shall be provided. Length of each such bond stone shall be less than two-third of the thickness of the wall.

Where bond stones of suitable length are not available precast cement concrete block of 1:3:6 mix (1 cement : 3 coarse sand : 6 graded stone aggregate 20mm nominal size) of cross section not less than 225 sqcm and length equal to the thickness of wall shall be used in lieu to bond stones. (This shall be applicable only in masonry below ground level and where masonry above ground level is finally required to be plastered).

At least one bond stone or a set of bond stones shall be provided for every 0.5 sqm of the area of wall surface. All bond stones shall be marked suitably with paint as directed by the EIC.

Quoin and Jamb Stones: The quoin and jamb stones shall be of selected stones neatly dressed with hammer or chisel to form the required angle. Quoin stones shall not be less than 0.01 cum in volume. Height of quoins and jamb stones shall not be less than 15cm. Quoins shall be laid header and stretcher alternatively.

Joints : Stones shall be so laid that all joints are fully packed with mortar and chips. Face joints shall not be more than 20mm thick.

The joints shall be struck flush and finished at the time of laying when plastering or pointing is not to be done. For the surfaces to be plastered or pointed, the joints shall be raked to a minimum depth of 20 mm when the mortar is still green.

Scaffolding: Single scaffolding having one set of vertical support shall be allowed. The supports shall be sound and strong, tied together by horizontal pieces, over which the scaffolding planks shall be fixed. The inner end of the horizontal scaffolding member may rest in a hole provided in the masonry. Such holes, however, shall not be allowed in pillars under one metre in width or near the skew back of arches. The holes left in masonry work for supporting scaffolding shall be filled and made good with cement concrete 1:3:6 (1 cement : 3 coarse sand : 6 stone aggregate 20 mm nominal size).

Curing: Masonry work in cement or composite mortar shall be kept constantly moist on all faces for a minimum period of seven days. In case of masonry with fat lime mortar curing shall commence tow days after laying of masonry and shall continue for at least seven days thereafter.

Protection : Green work shall be protected from rain by suitable covering. the work shall also be suitably protected from damage , mortar dropping and rain during construction.

e) **Square or Rectangular Pillars**

These shall be measured as walls, no extra payment shall be allowed for stone work in square or rectangular pillars over the rate for stone work in walls.

f) Tapered walls shall be measured net, as per actual dimensions and paid for as other walls.

Curved Masonry

Stone masonry curved on plan to a mean radius exceeding 6 metres shall be measured and included with general stone work. Stone work circular on plan to a mean radius not exceeding 6

metres shall be measured separately and shall include all cuttings and waste and templates. It shall be measured as the mean length of the wall.

5. FLOORING WORKS:

5.1General

All flooring shall be laid to the best practice known to the trade. The flooring shall be laid to the level except where slopes are called for on the drawings in which case the slopes shall be uniform and so arranged to drain in to the indicated outlets.
Particular care shall be exercised to ensure that all flooring, skirting and dado are perfectly matched for colour and finish. Sufficient extra tiles (not less than 5%) shall be cast/ordered to ensure an adequate supply of matched floor tiles. The contractor shall furnish for approval by the Project Manager, samples of each type of floor finish.

- The flooring in the building shall be as per the approved floor finish drawings and laid in such a way that limits in floor levels would not exceed the limits provided in the latest CPWD specifications or manufactures specifications.
- Wherever Vitrified Tile flooring is done, it shall be with multy grade/range 1st Quality tiles.
- Slope in floors shall be provided as per architectural drawings, else the levels at any place when checked over a distance of one meters in any direction should not show variation in floor level more than 3 mm.
- Rate for the items of flooring is inclusive of provision of sunken flooring and finishing edges of the same in bath kitchen, toilets, cutting holes for traps/ pipes etc., and nothing extra shall be paid on this account unless otherwise specified.
- The pointing work immediately above the dadoing works shall be done with proper slope.
- Protective layer to be provided of any type of flooring and nothing extra shall be paid on this account.
- The ceramic tile used for wall cladding shall be of Size 300x600mm. The lowest base price for the ceramic tiles for wall cladding shall be Rs.550/Sqm. The thickness for the tile shall not be less than 5mm.
- The ceramic tile used for flooring shall be of Size 600x600mm. The lowest base price for the ceramic tiles for flooring shall be Rs.540/Sqm.
- The vitrified tile used for skirting and flooring shall be of Size 600x600mm. The lowest base price for the vitrified tiles shall be Rs.600 /Sqm. The thickness shall be minimum 9.8mm as specified.
- The Heavy Duty Homogenous digitised vitrified tile used for flooring shall be of Size 600x600mm.of thickness not less than 16mm. The lowest base price for the vitrified tiles shall be Rs.800/Sqm

- The lowest base price for the granite used for flooring/staircase/counter slabs shall be Rs.2500/Sqm.

Granite Work

The granite stonework shall, in general, be carried out as per the CPWD Specifications and relevant specification for marble flooring, skirting, dado and tread/risers of steps under

Flooring Sub Head of the CPWD Specifications shall prevail.

Material

The tiles shall be of approved make and generally confirm to standard as per specifications. They shall be flat, and true to shape and free from blisters, crazing, welts, crawling or other imperfection detracting from their appearance. The tiles shall be tested as per standard acceptance criteria mentioned.

The tiles shall be vitrified, homogenous throughout its body structure and surface shall be mirror finish/satin/antiskid/matt finish as specified. The underside of the tiles shall not have any finish in order that the tiles may adhere properly to the base. The edges of the tiles shall be preferably free from shine or polish. However, any finish, if unavoidable shall be permissible on only upto to 50 percent of the surface area of the edges.

Preparation of Surface and Laying

Base concrete or the RCC slab on which the tiles are to be laid or RCC Column/Wall for cladding shall be cleaned, wetted and mopped. The bedding for the tiles shall be with cement mortar 1:4 (1 cement: 4 coarse sand) or as specified. The average thickness of bedding shall be 20mm for floor and 12 mm for wall cladding. Mortar shall be spread, tamped and corrected to proper levels and allowed to harden sufficiently to offer a fairly rigid cushion for the tiles to be set and to enable the mason to place wooden plank across and squat on it. Over this mortar bedding neat grey cement slurry of honey like consistency shall be spread at the rate of 3.3 kg of cement per square meter over such an area as would accommodate about 5-6 tiles. Tiles shall be soaked in water washed clean and shall be fixed in this grout one after another, each tile gently being tapped with a wooden mallet till it is properly bedded and in level with the adjoining tiles. The joints shall be kept as thin as possible and in straight lines or to suit the required pattern.

The surface of the flooring during laying shall be frequently checked with a straight edge about 2m long, so as to obtain a true surface with the required slope. Where full size tiles cannot be fixed, these shall be cut (sawn) to the required size, and their edge rubbed smooth to ensure straight and true joints. Tiles, which are fixed in the floor adjoining the wall, shall enter not less than 10mm under the plaster, skirting or dado. After tiles have been laid surplus cement slurry shall be cleaned off.

Pointing and Finishing

The joint shall be cleaned off the grey cement slurry with wire/coir brush or trowel and all dust and loose mortar removed. Joints shall then be grouted with epoxy grout of desired contrast colour (of any approved make). The floor shall then be kept wet for 7 days. After curing the surface shall be washed and finished clean. The finished floor shall not sound hollow when tapped.

Acceptance Crieteria For Tiles: -

S. No.	Property	Standard Laid Down
1.	Deviation in Thickness	± 5.0%
2.	Straightness of side	± 0.5%
3.	Rectangularity	± 0.6%
4.	Surface Flatness	±0.5%

5.	Water absorption	<0.08%
6.	MOHS Hardness	6
7	Flexural Strength (minimum)	30 N/MM2
8.	Abrasion Resistance	144 MM3
9.	Skid Resistance	0.6
10.	Breaking Strength	1113 N
11.	Density (G/CC)	2
12.	Frost Resistance	Frost proof
13.	Chemical Resistance	No Damage
14.	Thermal Shock Resistance	No Damage
15.	Colour Resistance	No Damage
16.	Thermal Expansion	9 x 10-6

Acceptance Crieteria For Tiles:

FINISHING WORKS:-

6.1 General:

Plastering, Painting, Polishing/ Varnishing to be carried out as per latest CPWD Specifications and as specified in DBR, and finishing schedule/tender drawings.

All plaster work shall be of the best workmanship and in strict accordance with the dimensions of the drawings. All plastering shall be finished to true levels including plumbs, without imperfections, and square with adjoining work. It shall form proper foundations for finishing materials such as paint etc. Masonry and concrete surface to which plaster is to be applied shall be clean, free from efflorescence, sufficiently rough and keyed to ensure proper bond.
Wherever directed all joints between RCC frames and masonry walls, shall be expressed by a groove in the plaster. This groove will exactly coincide with the joint beneath. At the corners of all windows and doors or other openings and wherever instructed, 24 gauge expanded galvanized metal mesh strips 300 mm wide shall be placed diagonally to prevent plaster cracks.
Where grooves are not called for, the joint between concrete and masonry in filling, chasing for conduits, pipes, boxes etc. shall be covered by 24 gauge expanded galvanized metal strips, 300 mm wide installed before plastering. The contractor shall supply all necessary labour, material, tools and scaffolding necessary for the completion of the work detailed. He shall be responsible to take proper precautions to all works from damage. Any work rejected through non-compliance

with the specifications or damaged work shall be removed and replaced at the expense of the contractor.

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

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

6.2. Plaster Work:

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

The plaster unless specified otherwise shall be average of 12 mm thick on walls and minimum 6 mm thick for the ceiling. The finished texture shall be as approved by the Project Manager. The mix for plaster unless otherwise specified, shall be one part cement and four parts sand, to walls and one part cement, 3 parts sand to ceiling.

The interior plaster shall be applied in one coat only. The surface shall be trowelled smooth to an approved surface. All plaster work shall be kept continuously wet for seven days.

The external plaster shall be minimum 15 mm. Preparations of walls to receive plaster work shall be the same as in internal plaster.

The terrace plaster shall be minimum 20 mm. Preparations of walls to receive plaster work shall be the same as in internal plaster. Both layers of all external plaster shall be waterproofed with approved water proofing powder added to cement in proportion of 1.5 Kg. to 50 Kg. of cement as per the manufacturers' instruction, for both the coats.

TEXTURE PAINT

(Work to be carried out as per Manufacturer Specification)

Providing and applying External Texture finish of approved makes as per approved design and pattern. Texture finish shall be applied over the plastered surface with required thickness shall 2 to 2.5 mm thickness to form the necessary approved design by using trowel / putty blade and it should be allowed for drying minimum 12 hrs before the application of top painting , a coat of Latex Based Elastomaric, Fibre Reinforced waterproof coating, 2 coats or more of external weather proof water based emulsion shall be applied over this and a coat of primer may be applied based on the approved texture pattern. Including surface preparation like through cleaning, prewetting & removal of loose mortars, etc. The work shall include for all the above items including labours, tools & tackles, required scaffholding, platforms, etc. for all heights, etc. The contractor shall supply all materials, labour, tools. ladders. scaffolding and other equipment necessary for the completion and protection of all texture work as herein specified shall be applied to all surfaces requiring texturing throughout the exterior of the building as given in the schedule of finishes or elsewhere. The texturing shall be carried out by a specialist sub- contractor, approved by the ENGINEER-IN-CHARGE. Care is to be taken that all surfaces to be textured are thoroughly cleaned and dry.

<u>Storage</u>

Storage of materials to be used on the job shall be only in a single place approved by the Engineer-in-Charge.

Application

For new work, the surface shall be thoroughly cleaned off all mortar dropping, dirt dust, algae, fungus or moth, grease and other foreign matter of brushing and washing, pitting in plaster shall make good, surface imperfections such as cracks, holes etc. should be repaired using white cement. The prepared surface shall have received the approval of the Engineer-in-charge after inspection before painting is commenced.

Before pouring into smaller containers for use, the texture paint shall be stirred thoroughly in its container, when applying also the texture paint shall be continuously stirred in the smaller containers so that its consistency is kept uniform. Dilution ratio of texture paint with potable water can be altered taking into consideration the nature of surface climate and as per recommended dilution given by manufacturer. In all cases, the manufacturer's instructions and directions of the Engineer-in-charge shall be followed meticulously. The lids of texture drums shall be kept tightly closed when not in use as by exposure to atmosphere the texture may thicken and also be kept safe from dust.

29.0 EPOXY FLOORING (BSL-3, BSL-2 & ANIMAL LABORATORY)

29.1 EPOXY FLOORING:

The joint less Epoxy flooring consists of Epoxy resin based joint less flooring over concrete surface including preparing the surface as required, application of epoxy primer, 3-4 mm or more in thickness epoxy screed and self-levelling 2mm minimum epoxy topping in required and approved shades. The entire job is to be undertaken by manufacturer's trained and skilled technicians to lay the Epoxy based floor.

Surface Preparation:

Applicator for the works should check out the moisture content in the existing RCC surface and if the percentage of moisture content is high same to be removed by using hot compressed air machine and the surface irregularities shall be removed by using floor screed. The concrete floors shall be roughened using hand grinders to provide a mechanical key for the epoxy screed to bond well the substrate. Presence of dust, laitance etc. should be completely cleaned before commencing the application. Moisture testing should be done to ensure moisture limit not exceeding 5%.

Epoxy Primer:

On the prepared floor surface epoxy primer with high penetrating properties shall be applied, as per manufacturer’s recommendations.

Self-levelling Epoxy topping:

The self-levelling top coat mixture shall be spread evenly by means of rollers and serrated trowels. The floor should be rolled by a spike roller to remove trapped airs to uniform level and smoothness.

29.2 **EPOXY COVING**

Epoxy primer shall be applied at the junctions of wall corner. Epoxy coving of size 70 mm on either side shall be applied to the junctions between wall & floor. It is to be made with solvent less epoxy screed/resin incorporating very high abrasion resistant aggregates. Screed mortar shall be

applied by trowel. The material should be compacted and finished with a round trowel to a smooth concave finish as per

manufacturer's specifications. Sealing of screed surface shall be made with sealer coat to ensure that a smooth finish is obtained in desired colour matching that of the floor finish as per manufacturer's specifications.

29.3 Performance properties of Epoxy flooring and Epoxy coving shall meet or exceed the following:

Finish	- Gloss/ Semi Gloss (as approved)
Compressive strength (ASTM C 579)	- 1000 psi
Tensile strength (ASTM C 307)	- 1750 psi
Hardness (ASTM D 2240)	- 85-90
Abrasion resistance (ASTM D 4060)	- 0.1 gm max. weight loss
Percent elongation (ASTM D 638)	- 0.15
Flexural Strength)ASTM C 580)	- 4000 psi
Bond strength (ASTM D 4541)	- > 400 psi (100% concrete failure)
Indentation (MIL D 3134F)	- No indentation
Coefficient of friction (ASTM D 2047)	- 0.6
Flamability (ASTM D 635)	- Self extinguishing
Water absorption (ASTM C 413)	- 0.2%
Heat resistance Limitation	- 140°F/60°C (for continuous exposure) 200°F/93°C (for intermittent spills)
Cure rate allow (at 77°F/25°C)	- 06 hours for foot traffic 18 hours for light traffic 24 hours for normal operation

Guarantee / Warranty for wall coating : The Contractor shall give Guarantee / Warranty for Epoxy wall coating and Flooring for a period of 5 years

7.FALSECEILING

General

a.The false ceiling in the buildings shall be asper the approved finishing schedule appended in DBR, tender drawings as per latest CPWD specifications or manufactures specifications.

b.False ceiling items in general are carried out as per the manufacturer‘s specifications/ as directed by the Engineer – in –Charge.

c.Location of particular type of false ceiling shall be as per relevant drawing, in its absence written approval of the Engineer – in - charge shall be obtained.

d.The false ceiling tiles from manufacturers using recycled materials shall be preferred.

e.Trap doors, as required, of approved size and design shall be provided.

Material – General Description

Providing and fixing tiled false ceiling of approved materials of size 595x595 mm in true horizontal level suspended on inter locking metal grid of hot dipped galvanized steel sections (galvanized @ 120gsm/sqm, both side inclusive) consisting of main "T" runner with suitably spaced joints to get required length and of size 24x38mmmade from 0.30mm thick (minimum) sheet, spaced at 1200mm center to center and cross "T" of size 24x25mm made of 0.30mm thick(minimum) sheet, 1200mm long spaced between main "T" at 600mmcenter to center to form a grid of 1200x600 mm and secondary cross T of length 600mm and size 24x25mm

made of 0.30 mm thick(minimum) sheet to be interlocked at middle of the 1200x600mm panel to form grids of 600x600mm and wall angle of size 24x24x0.3 mm and laying false ceiling tiles of approved texture in the grid including, wherever, required, cutting/making, opening for services like diffusers, grills, light fittings, fixtures, smoke detectors etc. Main "T" runners to be suspended from ceiling using GI slotted cleats of size 27 x 37 x 25 x1.6x mm fixed to ceiling with 12.5 mm dia and 50 mm long dash fasteners,4mm GI adjustable rods with galvanised butterfly level clips of size 85 x30 x 0.8 mm spaced at 1200mm center to center along main T, bottom exposed width of 24 mm of all T-sections shall be pre-painted with polyester paint, all complete at all heights as per specifications drawings and as directed by Engineer-in-charge.

Metal Ceiling

GI Metal Ceiling Lay in perforated Tegular edge global white color tiles of size 595x595 mm and 0.5mm thick with 8mmdrop; made of GI sheet having galvanizing of 100 gms/sqm(both sides inclusive) and 20% perforation area with 1.8mmdia holes and having NRC (Noise Reduction Coefficient) of 0.5, electro statically polyester powder coated of thickness 60 microns (minimum), including factory painted after bending and perforation.

Gypsum Board

12.5 mm thick fully Perforated Gypsum Board & tile made from plasterboard having glass fibre conforming to IS: 2095 part I ,of size 595x595 mm, having perforation of 9.7x9.7 mm at19.4 mm c/c with center borders of 48 mm and the side borders of 30 mm, backed with non woven tissue on the back side, having an NRC (Noise Reduction Coefficient) of 0.79.

Calcium Silicate

15 mm thick densified tegular edged eco friendly light weight calcium silicate false ceiling tiles of approved texture of size 595 x 595 mm in true horizontal level. The calcium silicate ceiling tile shall have NRC value of 0.50 (Minimum), light reflection> 85%, non-combustible as per B.S. 476 part IV, 100% humidity resistance and also having thermal . conductivity <0.043 w/mK.

Fire Performance

Products must be fully tested in accordance with BS 476 parts 6 and 7 with regard to fire propagation and surface spread of flame.
drawings and to the satisfaction of Engineer-in-charge.

8.0 MODULAR WALL AND CEILING PANELS

The internal partition walls and ceiling in BSL-3 Laboratory, BSL-2 Laboratory and Animal Facility shall be provided in pre-fabricated, non particle shredding modular panels in powder coated finish. The prefabricated wall and ceiling panels should provide impervious and monolithic construction and surface finish. Outer/external brick walls should be provided with cladding from inside with similar pre-fabricated wall panels.

The modular wall and ceiling panels shall be in specified thickness and constructed in 0.8 mm thick GSS sheet on both sides, in-filled with PUF insulation (density 38-40kg/m3), finished in epoxy plaster powder coating in approved shade, oven lacquered smooth to 60 to 80 micron thickness. The surface finish shall sustain Formalin/H2O2 fumigation of lab spaces.

All the joints between panels, cut-outs, openings and penetrations shall be sealed with silicone sealant as approved by Engineer-in-charge.

The thickness of the wall and ceiling panels for different types of laboratories shall beas under:

a. Wall & Ceiling Panels in BSL-3 Laboratory : 80-82 mm thickness
b. Wall & Ceiling Panels in BSL-2 Laboratory : 50-52 mm thickness
c. Wall & Ceiling Panels in Animal Laboratory : 50-52 mm thickness

The wall and ceiling panels should be supported on heavy duty aluminium profile supported by anchoring. All wall and ceiling corners shall be provided with minimum 50 mm (R-50) aluminium coving, in the wall and ceiling colour, corners should be rounded at turn from X-Y direction, milled solid aluminium spheres should be provided in same colour at the 3-D(wall/ceiling/wall junction) and 2-D(wall/ceiling junction). The ceiling should be adequately supported with suspension and hangar system.

Each modular wall panel should not be of more than 1200 mm width. All the vertical and horizontal joints of wall and ceiling panels and covings should be sealed with silicone sealant to render leak proof installation.

The conduits for providing wires and cables for light, power, data, voice and other services shall be factory inserted in the wall panels, as per requirement and as per approved drawings by the Engineer-in-charge.

Service pendant/s constructed/manufactured in SS 304 (18 gauge) shall be provided for connecting services and utilities (like steam, water, compressed air, CO_2 etc.) inside the BSL-3 Laboratory. The ceiling pendant penetration shall be perfectly caulked and sealed with Epoxy Sealant not to allow any ingress of air, due to negative pressure.

After installation of wall and ceiling panels and sealing of all the joints, openings, penetrations, the same shall be soap bubble tested for any leakage. In case any air leakage is detected, the same shall be repaired and tested again, till no air league/ingress of air is observed.

9.0 FIRE CHECK DOOR OF 120 MINUTES FIRE RATING

Providing and fixing in position single / double, leaf fire check doors and frames at all levels of approved make, design, finish, tested and certified at CBRI, Roorkee complete in all respect as per specifications and direction of Engineer-In-Charge and consisting of: -

Door frame shall be Single rebate Grooved profile of size 125 x 60 mm made out of 1.60mm (16gauge) minimum thick galvanized steel sheet confirming to IS 2260 & 4351 with grooved seal. Frames shall be Mitered and field assembled with self-tabs. All provision should be mortised, drilled and tapped for receiving appropriate hardware. Rubber door silencers should be provided on the striking jamb. Frames should be provided with back plate bracket and anchor fasteners for installation on a finished plastered masonry wall opening. Once frame installed should be grouted with cement & sand slurry necessary for fire doors on the clear masonry opening.

Door leaf shall be 46mm thick fully flush double skin door with or without vision lite. Door leaf shall be manufactured from 1.2mm (18guage) minimum thick galvanised steel sheet. The internal construction of the door should be rigid reinforcement pads for receiving appropriate hardware. The infill material shall be resin bonded honeycomb core with fire rated proprietary insulation filler bonded to both faces of sheet with lock seam joints at style edges. All doors shall be factory prepped for receiving appropriate hardware and provided with necessary reinforcement for hinges,

locks, and door closers. The edges should be interlocked with a bending radius of 1.4mm. For pair of doors astragals has to be provided on the meeting stile for both active and inactive leaf. Vision lite wherever applicable should be provided as per manufacturer's recommendation with a beading and screws from inside.

The door frames and door shutters shall be primed with 'H' primer and finished with PU/Powder coated .

The shutter would be mounted with SS Ball Bearing Hinges of size 100mm x 75mm x 3.0mm of Becker Fire Solutions (4 Nos per leaf), appropriate openings for vision panel glass. Prototype Test certificate for a test carried out earlier at CBRI Roorkee for fire rating of doors, shall be attached along with manufacturers test certificate.

All door shall be factory made and rate to include installation, Fire rated hardware like hinges, panic bar, door closer, Vision Panel 300x 200, Glass, lock, handles, coordinator etc. as desired with necessary reinforcement and direction of Engineer in charge.

Applicable Codes and Standards:

All standards, specifications, acts, and codes of practice referred to herein shall be the latest editions including all applicable official amendments and revisions.

List of certain important Indian Standards, Acts and Codes applicable to this work is given below. However, the applicable standards and codes shall be as per but not limited to the list given below:
IS: 277 Galvanised steel sheet (plain and corrugated) of GPL Grade with Z 120 Coating.
IS: 3614 Metallic and non-metallic fire check doors–Resistance test and Part-2 performance criteria.

Material: -

a)Door frame shall be Single Rebate Grooved profile of size 125 x 60 mm made out of 1.60mm (16gauge) minimum thick galvanized steel sheet confirming to IS 2260 & 4351 with grooved seal. Frames shall be Mitered and field assembled with self-tabs. All provision should be mortised, drilled and tapped for receiving appropriate hardware. Rubber door silencers should be provided on the striking jamb. Frames should be provided with back plate bracket and anchor fasteners for installation on a finished plastered masonry wall opening. Once frame installed should be grouted with cement & sand slurry necessary for fire doors on the clear masonry opening.

b) Door leaf shall be 46mm thick fully flush double skin door with or without vision lite. Door leaf shall be manufactured from 1.2mm (18guage) minimum thick galvanised steel sheet. The internal construction of the door should be rigid reinforcement pads for receiving appropriate hardware. The infill material shall be resin bonded honeycomb core with fire rated proprietary insulation filler bonded to both faces of sheet with lock seam joints at style edges. All doors shall be factory prepped for receiving appropriate hardware and provided with necessary reinforcement for hinges, locks, and door closers. The edges should be interlocked with a bending radius of 1.4mm. For pair of doors astragals has to be provided on the meeting stile for both active and inactive leaf. Vision lite wherever applicable should be provided as per manufacturer's recommendation with a beading and screws from inside.

c) The door frames and door shutters shall be primed with 'H' primer and finished with PU/Powder coated. The shutter would be mounted with SS Ball Bearing Hinges of size 100mm x 75mm x 3.0mm of Becker Fire Solutions (4Nos per leaf), appropriate openings for vision panel glass.

Prototype Test certificate for a test carried out earlier at CBRI Roorkee for fire rating of doors, shall be attached along with manufacturers test certificate

All door shall be factory made and rate to include installation, hardware's like hinges, panic bar, door closer, Vision Panel 300x 200, Glass, lock, handles, coordinator etc. as desired with necessary reinforcement and direction of Engineer in charge.

The following information shall be submitted by the contractor for obtaining approval of the Engineer-in-charge before start of work.

Product Data	:	Manufacturer's data sheets on each product to be used, including preparation instructions and recommendations. Storage and handling requirements and recommendations. Details of construction and fabrication. Installation methods.
Shop Drawings	:	Detailed plans and elevations, details of framing members, anchoring methods, clearances, hardware, and accessories clearly shown.
Manufacturer's Certificates	:	Certifying that products meet or exceed specified requirements.
Operation and Maintenance Data	:	Submit lubrication requirements and frequency, and periodic adjustments required.
Name of installer	:	Approved by the manufacturer, specializing in performing work of this section with minimum three years' experience.
Manufacturer's warranty	:	For all parts and components of the fire rated door set system except counterbalance spring and finish for 5 years

Delivery, Storage and Handling:-
Fire rated door set shall be delivered and stored in manufacturer's unopened packaging until ready for installation. It shall be protected from exposure to moisture and shall be stored in a dry, warm, ventilated weather tight location.

Installation: -

The Contractor shall furnish all materials, labour, operations, equipment, tools & plant, scaffolding and incidentals necessary and required for the completion of all metal work in connection with steel doors, as called for in the drawings, specifications and bill of quantities which cover the major requirements only. Anything called for in the tender documents shall be considered as applicable to the items of work concerned. The supply and installation of additional fastenings, accessory features and other items not specifically mentioned, but which are necessary to make a complete functioning installation shall form a part of this contract.

The Contractor shall submit the details of manufacturers from the list of approved makes from which he intends to procure the doors. The contractor shall procure the doors only after the approval of the manufacturer from the Engineer-in-charge.

All metal work shall be free from defects, impairing strength, durability and appearance and shall be of the best quality for purposes specified made with structural proprieties to withstand safety strains, stresses to which they shall normally be subjected to. All fittings shall be of high quality and as specified and as per approval. The Contractor shall strictly follow, at all stages of work, the stipulations contained in the Indian Standard Safety Code or its Equivalent British Standard and the provisions of the safety code and the provision of the safety rules as specified in the General Conditions of the Contract for ensuring safety of men and materials. Any approval, instructions, permission, checking, review, etc. by Engineer-in- Charge, shall not relieve the Contractor of his responsibility and obligation regarding adequacy, correctness, completeness, safety, strength, quality, workmanship

a) Door closer confirming to CE & EN 1154 and B.S. – 476, Part-22, two hours' fire door.
b) Panic Exit Device – Single / Double leaf confirming to CE & EN 1154 and B.S. – 476, Part-22, two hours' fire rated.
c) Mortice Lock with lever handle confirming to CE & EN 122090 / DIN 18251 and B.S.- 476, Part-22, two hours' fire rated.
d) Stainless steel ball bearing hinges 4 nos. on each side of shutters size 100 mm x 100 mm x 3 mm with screws etc. complete.
e) Vision panel: 6 mm thick borosilicate toughened glass 120 min fire rated glass on each leaf of size 300 x 200 mm.

Testing: -
The fire doors shall be tested by CBRI , Roorkee. Testing charges shall be paid by the contractor.

10.0 STAINLESS STEEL RAILING WORK

The scope of the work includes preparation of the shop drawings (based on the site requirement and architectural drawings), fabrication, supply, installation and protection of the stainless steel railing till completion and handing over of the work.

The stainless steel work shall be got executed through specialized fabricator having experience of similar works. The Contractor shall submit the credentials of the fabricator for the approval of the Engineer-in- Charge.

The Contractor shall submit shop drawings, for approval of the Engineer -in-Charge, for fabricating stainless steel railing with detailing of M.S. stiffener frame work backing along with the fixing details of the M.S. frame work to the R.C.C columns. The details of the joints in the stainless steel railing including location, etc. shall also be shown in the shop drawings.

The Contractor shall procure and submit to the Engineer-in-Charge, samples of various materials for the railing work, for approval. After approval of samples, the Contractor shall prepare a mock up for approval of Engineer-in-Charge / Consultant. The material shall be procured, and the work taken up only after the approval of the mock up by the Engineer-in-Charge. The mock-up shall be dismantled and removed by the contractor as per the directions of the Engineer-in-Charge. The cost of samples shall be borne by the contractor.

The stainless steel shall be of grade 304 with brushed steel satin finish and procured from the approved manufacturer. It shall be without any dents, waviness, scratches, stains etc.

The required joints in the railing provided as per the architectural drawings, shall be welded in a workmanlike manner including grinding, polishing, buffing etc. all complete and

compacted. The temporary clamps provided and fixed to hold the stainless-steel railing, in position shall be Removed after the concrete has set properly. The junction of the flooring and the cladding shall be neatly filled with weather silicone sealant of approved colour and shade.

One test (three specimens) for each lot shall be conducted for the stainless-steel pipe in the approved laboratory. Therefore, the material shall preferably be procured in one lot from one manufacturer.

The finished surface shall be free of any defects like dents, waviness, scratches, stains etc. and shall have uniform brushed steel satin finish. Any defective work shall be rejected and redone by the Contractor at his own cost. The finished surface shall therefore be protected using protective tape which shall be removed at the time of completion of the work. The surface shall then be suitably cleaned using nonabrasive approved cleaner for the material.

The work shall include all inputs of labour, materials (including stainless steel pipes, welding, brazing, concrete, protective film, weather silicone sealant etc including cost of providing and fixing M.S. frames), T & P other incidental charges, wastages etc. The items also included providing and fixing stainless steel anchor fasteners for fixing railing.

The railing shall be fixed in position using stainless steel pipes, stainless steel posts of required diameters and thickness as per approved drawing and polished to satin finish including cutting, welding, grinding, bending to required profile and shape, hoisting, butting, polishing etc.

REBAR COUPLERS

Providing and fixing parallel threaded couplers conforming to IS code on “Reinforcement Couplers for Mechanical Splices of Bars for Concrete Reinforcement - Specification”, to reinforcement bars including threading, enlargement at connection by forging, protecting the prepared reinforcement bars and related operations as required to complete the works per direction of Engineer-in-Charge.

Scope

The work shall covers the use of reinforcing rebar coupler for joining reinforcing bars to another reinforcing bar to achieve the required length. The coupler made with the process of cutting, cold forging and threading.

Couplers systems

Mechanical splices

The mechanical splice system consists in enlarging the reinforcing bar ends by cold upsetting prior to threading them. The bars are cut square before the enlarging operation

The combination of the square cutting and the cold-upsetting reduces the length of the bar by approximately 40 to 75 mm on each end, depending on the bar size. Extra-long threads are used to assist alignment, or when joining bars that cannot be turned.

Standard splices
Standard splices are accomplished by use of a standard female coupler matching the thread size made on the bars.

Position splices

When both bars would be a burden to rotate, for example because of their size or length, the splice system simply extends the thread onto the ribs of the bar, thereby enabling the coupler to be fully screwed onto it. It is then unscrewed from one bar and back onto the second bar to accomplish the connection.

Transition splices
When there is a need to splice bars of different sizes, it is allowable in most cases to reduce the size of the larger bar and to use a standard coupler.

Headed bars
Development of reinforcement is the main use of headed bars : They conveniently replace hooked bars as end anchorages in congested areas. They can also be used to reduce lapping length, or as confinement or shear reinforcement where placing of stirrups is difficult. Typical applications include exterior beam-column connections, roof corners, pile feet, pile caps, cantilevered members, corbels, etc.

Testing codes to be followed
Initial connection Tensile testing required for prequalification by the engineer shall be borne by the Supplier based on one tensile test per bar-diameter as required for the Project and as per IS 1786 standard.IS 1786 for rebar, ACI 318 for Coupler Joint.

Installation and construction operation
The mechanical connection is achieved by screwing the coupler onto one bar, and then screwing in the second bar. Contrary to taper threads, no torque wrench is necessary, and mis-assembly by crossing threads is impossible. Isometric parallel threads have equal resistance in tension and compression. Therefore, the tensile performance of the splice will not be affected if the two bars are not in butt-to-butt contact. Since the safety ratio on the thread engagement length is designed to be at least two pitches, a gap between both bars is admissible. Bars that are not properly aligned may still be connected if this misalignment is within reasonable limits, depending on the length of bar and on their stiffness. Large bars must always be properly aligned

11.0 STONE CLADDING WORK

Providing and fixing dry cladding upto 15 metre heights with 30mm thick gang saw cut stone with (machine cut edges) of uniform colour and size upto 1mx1m, fixed to structural steel frame work and/ or with the help of cramps, pins etc. and sealing the joints with approved weather sealant as per Architectural drawing and direction of Engineer-in-charge.

The work shall be carried out as per CPWD specification 2009 Shop Drawings and Sequence of execution for cladding work shall be submitted by the contractor for approval of Engineer-in-charge. The work shall be executed after the approval of Engineer-in-charge.

12.0 FIRE STOP SEALANT

Providing and applying acrylic fire stop sealant, with minimum 2 hours fire rating when tested in accordance with UL 1479 standards, shall be used along the periphery of ducts & Metal pipes without insulation The products shall be age tested as per Dafstb and DIBT standards. The products shall carry test certificate for mold resistance rating of 0 as determined by ASTM G21-96. and shall have a VOC content of approx. <1 g/l as per LEED 2009.The products shall be UL listed & classified and shall bear the UL approval logo on the packing.(considering 5 mm joint width & 13 mm thick depth of sealant)

13.0 STAINLESS STEEL HARDWARES FOR DOOR/WINDOW/VENTILATORS

The stainless-steel fittings and fixtures shall be machine made and free of fabrication marks, residual effects of welding /riveting etc.

The fitting shall be finished in a Satin fish (brushed finish-satin's commercial purpose) except wherever specified otherwise. The brush effect shall be uniform and without ant variations.

Irrespective of the stipulations contained above, the contractor shall produce samples for all the fitting in advance and a written approval for the chosen sample shall be obtained from the ENGINEER-IN-CHARGE. The decision of the ENGINEER-IN-CHARGE in respect of the specification, quality and make of fitting to be used at site shall be final and binding on the contractor. Nothing extra shall be payable on this account.

All the fittings shall provide with all such accessories as are required to complete the item in working condition whether specifically mentioned or not in the Bill of Quantities, specification & elsewhere in this tender document. The quoted rates shall be deemed to be all inclusive for a complete item fit for use including all material. Labour, T & P, Specials, fixing arrangements, nuts, bolts, screws, bushes, all required connection pieces etc. as well as making good the surface wherever required. All the accessories including brackets, nuts, bolts, screws, bushes etc. shall be of the quality and make specified by the manufacture of the fitting.

All the fitting shall be got fixed through the authorized "Fixing Agency" on the approved list of manufacturers of fitting. The said Fixing Agency shall be got approved from the ENGINEER-IN-CHARGE before start of fixing at site.

All the fitting including accessories shall be accompanied with certificate of origin and representative test certificate of conformance with relevant code form the manufacturer with each lot supply. The test certificate should clearly indicate the lot numbers of the supplied fittings.

14.0 FRAMELESS SWING GLASS DOOR

Providing, supplying and fixing of Frameless Swing Glass Door in glazing using 12mm thick toughened glass die cast patch fitting with stainless steel cover including fixing of patch fittings, floor springs, locks, handles etc. using the hardware items as detailed, complete in all respects as per detailed drawings, manufacturers specifications and direction of Engineer in charge.

a) **Single Leaf:-** Swing Glass Door which includes one no. each of fittings such as Top Pivot-1nos., Toprail- 1nos., Bottom rail with lock and 'H' Pull (600mmx32mm) Handle - 1 set, Floor spring with standard spindle conforming to EN-1154, tested for 500,000 cycles, non-handed unit suitable for doors up to 150kg leaf weight, with variable spring strength (size-EN 2-4) and closing speed adjustment 145°-15° & 15°-0°, fixed hold open at 90° and SS cover plate - 1 set. The top/bottom rail shall be 65mm height and 31mm thick with SSS cover on both sides complete. Featuring hydraulically fully controlled closing cycle including cement box, Finish: Satin Stainless Steel. The above work complete in all respect as per approved drawings and to the satisfaction of Engineer-in- charge.

b) **Double Leaf:-** Swing Glass Door which includes two no. each of fittings such as Top Pivot-2 nos., Top door rail - 2 nos., Bottom door rail and lock -2 sets with 'H' Pull Handle (600mm x 32mm) - 2 set, Floor spring with standard spindle conforming to EN 1154, tested for

500,000 cycles, nom-handed unit suitable for doors up to 150 kg leaf weight, with variable spring strength (size EN 2-4) and closing speed adjustment 145°-15° & 15°- 0°, fixed hold open at 90° and SS cover plate-2 sets. The top/bottom rail shall be of 65mm height and 31mm thick with SSS cover on both sides complete. Featuring hydraulically fully controlled closing cycle including cement box, Finish: Satin Stainless Steel. The above work complete in all respect as per approved

14.0 DOUBLE GLAZED VIEW PANEL

The view panels shall be double glazed and designed to fit flush into the wall panel system on both sides with min. 5 mm thick clear toughened glass. Glass shall be fixed onto aluminium frame work with high performance double coated black colour structural glazing tape (3 M VHB or equivalent). Aluminium frames shall be with 2 mm thick sheet formed to match panel thickness with epoxy powder coating of 60 to 80 micron thickness. The gap between the glasses shall have anti-moisture with silica gel granules/molecular seive. Glazing shall be perfectly flush with the outer surface of the frame and wall panel. All joints shall be taped and sealed with silicon sealant.

15.0 METTALIC DOOR AND BIOSAFETY DOOR

Metallic Door frames shall be fabricated from 1.25 mm thick galvanized steel sheet to the required profile and dimensions. The door shutters shall be manufactured from 0.8 mm galvanized sheets press formed to double skin hollow profile with lock seam joints at stile edges. Door frames should be prepared for suitable hardware as scheduled and should have necessary reinforcement to withstand regular wear and tear. All provision should be mortised, drilled and tapped for receiving the hardware. Rubber door silencers should be provided on the striking jamb.

Metallic Door Shutters shall be 44 mm thick fully flush double skin door and shall have no visible screws or fasteners on either face. Door leaf shall be manufactured in 0.8 mm (22 g) thick galvanized steel sheet. The internal construction of the door shall be rigid with steel stiffners/pads for receiving appropriate hardware. The infill material shall be resin bonded honeeycomb paper core or as approved by Engineer-in-charge.

Frames and shutter shall have factory finish in thermo setting polyurethane aliphatic grade paint (35 micron DFT) or powder coated in approved color.

Frames and shutters to have factory finishes pre-punched cutouts to receive specific hardware's like hinges, lock, door handles, door closer etc.

The doors shall be provided with heavy duty door closer, stainless steel kick plate on outer side, Stainless Steel handles, Key -Lock (except doors inside the BSL-3 Laboratory area), lip gasket on sides and top, drop down gasket at bottom.

Double glazed vision panel to be provided in door shutters with toughened float glass of 5 mm thickness, installed flushed on both sides of door shutter. Glass to be fixed with high performance structural glazing tape (3 M VHB or equivalent)

Biosafety Doors

a) The Biosafety Doors shall be in SS 316 no. 4 finish construction designed to maintain containment. Frames will be constructed in SS 316 no. 4 finish designed to accommodate flush mounting of access devices such as door access buttons, status lights, magnetic locks etc.

b) Biosafety doors shall be provided for Fumigation Airlocks and Showers of BSL-3 Laboratory and Effluent decontamination plant room.
c) The Biosafety door shall be air-tight doors, provided with inflatable gaskets, connected to compressed air line from the air compressor, to ensure perfect sealing when in closed position. The inflatable gaskets shall be interlocked with the door interlock system such that when the door is closed, the gasket should inflate and seal the door and when the door release button is pressed, the gasket should deflate to allow opening of the door.
d) The doors shall be capable to withstand room differential pressure and pressure testing loads.
e) The door sealing arrangement be through inflatable gaskets in high grade neoprene
f) Interconnecting compressed air supply piping and pressure regulators shall be provided for each biosafety door
g) Each Biosafety Door shall be factory tested for air tightness and no leakage at +/- 250 Pa before delivery at site.
h) Doors for Airlocks shall be provided with sealed window of approx. 400 mm for viewing, complete with double glazed laminated tempered glass
i) All surfaces shall be free from rough edges, burrs, sharp corners or edges
j) Door shall be complete with all fittings and accessories like door closer, handles etc. All fittings and accessories shall be in stainless steel.

16.0 STRUCTURAL GLAZING

The Structural Glazing work shall be unitized and shall be executed by specialized agency.

The contractor shall get design, engineering, test, fabricate, deliver, install, and guarantee all construction necessary to provide a complete structural glazing system to the proposed building, all in conformity with the approved designs and drawings, specifications and all relevant construction regulations including providing any measures that may be required to that end, not withstanding any omissions or inadequacies of the Drawings.

Without limiting the generalities of the foregoing, the Structural glazing System shall include, without being limited to, the followings:

(i) Metal frames, glass glazing, spandrels, ventilators, finish hardware, copings metal closure, windows etc.
(ii) All anchors, attachments, reinforcement and steel reinforcing for the systems required for the complete installations.
(iii) All thermal insulation associated with the system. All fire protection associated with the system.
(iv) All copings, end closure and metal cladding to complete the system.
(v) All sealing and flushing including sealing at junctions with other trades to achieve complete water tightness in the system.
(vi) Isolation of dissimilar metals and parts
(vii) Anticorrosive treatment on all metals used in the system. Polyester powder coating on aluminium sections

The contractor shall also be responsible for the followings:

1. Submission of Shop Drawings, Engineering data and Structural Calculations in connection with the design of the Structural glazing System for the approval of Engineer-in-charge.
2. Mock-ups, samples and test units.
3. Performance Testing of the Structural Glazing framing and glazing assembly.
4. Co-ordination with work of other trades.
5. Protection.
6. All final exterior and interior cleaning and finishing of the Structural Glazing

7. As-built record drawings
8. Guarantees and Warranties.
9. All hoisting, staging and services.
10. Conceptualising and design of a suitable maintenance system for curtain/structural glazing.

The water tightness and structural stability of the whole Structural glazing System shall be guaranteed and shall be the prime responsibility of the Contractor. Any defect or leakage found shall be sealed and made good all at the expense of the Contractor.

The Structural Glazing system shall be designed to provide for expansion and contraction of components which will be caused by an ambient temperature range without causing buckling, stress on glass, failure of joint sealants, undue stress on structural elements or other detrimental effects. Specific details should be designed to accommodate thermal and building movements.

The Contractor shall submit Structural analysis & design and shop drawings for the loads conforming to IS 875 part III (the system must pass the proof test at 1.5 times design wind pressure without any failure), and seismic loads as per IS-1893. including functional design of the aluminum sections for fixing glazing panels of various thicknesses, aluminium cleats, sleeves and splice plates etc. gaskets, screws, toggles, nuts, bolts, clamps etc., structural and weather silicone sealants, flashings, fire stop (barrier)cum-smoke seals, microwave cured EPDM gaskets for water tightness, pressure equalisation & drainage and protection against fire hazard. This shall include for linear as well as curvilinear portions of the building. The design shall also ensure that the maximum deflection of any member shall not exceed 1/175 of the span between supports or 20mm, whichever is less for vertical elements & 1/250 of the span between supports for horizontal elements. Also no failure of structural silicone Jolts, damage to joinery, components, or permanent set in the framing members in excess of 0.2 percent of the span shall occur under 1.5 times the design load.

Specifications:

a) Aluminium extruded tubular and other aluminium sections shall be as per the approved designs shop drawings, the aluminium quality as per grade 6063 T5 or T6 as per BS 1474,including super durable powder coating of 60-80 microns conforming to AAMA 2604 of required colour and shade as approved by the Engineer-in-Charge. No visual variation in shade shall be permitted.

b) Brackets shall be M.S. hot dip galvanised / Aluminium alloy of 6005 T5 of required sizes, sections and profiles etc. to accommodate 3 Dimentional movement for achieving perfect verticality and fixing structural glazing system rigidly to the RCC/ masonry/structural steel framework of building structure using stainless steel anchor fasteners/ bolts, nylon seperator to prevent bimetallic contacts with nuts and washers etc. of stainless steel grade 316, of the required capacity and in required numbers.

c) Sealing and filling, two part pump filled, structural silicone sealant and one part weather silicone sealant compatible with the structural silicone sealant of required bite size in a clean and controlled factory / work shop environment , including double sided spacer tape, setting blocks and backer rod, all of approved grade, brand and manufacture, as per the approved sealant design, within and all around the perimeter for holding glass.

d) Shall fix in position flashings of solid aluminium sheet 1 mm thick and of sizes, shapes and profiles, as required as per the site conditions, to seal the gap between the building structure and all its interfaces with curtain glazing to make it watertight.

e) Shall make provision for drainage of moisture/ water that enters the curtain glazing system to make it watertight, by incorporating principles of pressure equalization, providing suitable gutter

profiles at bottom (if required), making necessary holes of required sizes and of required numbers etc. complete.

f.) The Glazing/Glass shall be vision glass panels (IGUs) comprising .of hermetically-sealed 6-12- 6 mm insulated glass (double glazed) vision panelunits of size and shape as required and specified, comprising of an outer heatstrengthened float glass 6mm thick, of approved colour and shade withreflective soft coating on surface # 2 of approved colour and shade, an innerHeat strengthened clear float glass 6mm thick, spacer tube 12mm wide,dessicants, including primary seal and secondary seal (structural silicone sealant) etc. all complete for the required performances, as per the Architecturaldrawings, as per the approved shop drawings, as specified and as directedby the Engineer-in-Charge. The IGUs shall be assembled in the factory/workshop of the glass processor.

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i) Coloured tinted float glass 6mm thick substrate with reflective soft coatingon face # 2, + 12mm Airgap + 6mm Heat Strengthened clear Glass of approvedmake having properties as visible Light transmittance (VLT) of 25 to 35 %,Light reflection internal 10 to 15%, light reflection external 10 to 20 %, shading coefficient (0.25- 0.28) and U value of 3.0 to 3.3 W/m2 degree K etc. Theproperties of performance glass shall be decided by technical sanctioningauthority as per the site requirement.

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Heat strengthened glass shall be examined to detect and discard any glass which exceeds the following tolerance: 1.5mm bow in 600mm: 3mm bow in 1500mm; 6mm bow in 3000mm; 9mm bow in 4500mm. Where the strengthening process results in essentially parallel ripples or waves, the deviation from flatness at any peak shall not exceed 0.13mm and the difference between adjacent peaks shall not exceed 0.13mm. Where bow tolerance and wave tolerance differ, the stricter requirements shall govern.

Following test shall be carried out by the contractor/manufacturer at his own cost as per following provisions:

Thickness	Impact Strength	Fragmentation	Surface Compression	Bending strength
IS-2835-1987	IS-2553-PART-I	IS-2553-PART-I	ASTM C-1048-90	DIN 1249-PART-12

g) Fabrication and Installation

Installation shall be in true line vertically and horizontally.

Work shall be done by competent workmen who are thoroughly skilled in their trade. Assemblies shall be neat and free of defects that impair strength, function or appearance. The work shall be accomplished in compliance with the specified criteria without buckling opening or joints. Under stress on fasteners, sealants and gaskets, opening of welds cracking of glass leakage noises and other harmful effects.

As far as practicable fitting and assembly of the work, shall be done in the shop.

All exposed work shall be carefully matched to produce continuity of line and design. All joints in exposed metal work, unless otherwise shown or specified shall be accurately fitted end rigidly secured with joint sizes conforming to industry standards.

Except where otherwise shown specified, approved or directed, the method of assembly and joining shall be as per approved shop drawings. Fabricate and fasten metal work so that the work will not be distorted nor the fasteners over stressed from the expansion and contraction of the metal.

All welding shall be in accordance with the appropriate recommendations of the Indian welding codes and shall be done with electrodes and/ or by methods recommended by the manufacturer of the alloys being welded. All welds behind finished surfaces shall be done as to minimize distortion and/ or dis-coloration on the finished side. All weld spatter and welding oxides on finished surfaces shall be removed by de-scaling and/ or grinding.

Unless otherwise shown or specified, all weld beads or exposed surfaces shall be ground and finished to match and blend with finish on adjacent parent metal. Grinding and polishing of nonferrous metal shall be done only with clean wheels and compounds free from iron and iron compounds. No soldering and/ or brazing shall be allowed.

The Contractor shall conceal all the fasteners where visible in the finished work.

All aluminium components shall be fabricated before finishing, Cutting of components will not be acceptable.

As the building is exposed to varying weather actions, all fasteners shall be stainless steel, self tapping screws with Aluminium brackets. Steel anchors shall be pre-holed and galvanized. The bolts shall be steel chromium plated along with nuts and covered with butyl sealing compound.

Where aluminium comes into contact with masonry, brickwork, concrete, plaster or dissimilar metals, it shall be coated with an approved insulation lacquer, paint or plastic tape to ensure that electro-chemical corrosion is avoided.

h) Sealant and Gasket Application

Sealant and gasket shall be provided wherever shown in the approved shop drawings or required for a permanently weather tight installation. The sealing mechanism for each location and use shall be as indicated on approved shop drawings and also in those locations where a mechanism is necessary but is not indicated.

All adjoining surfaces shall be protected to receive sealants against staining by masking and/ or other methods.

Joints and joint surfaces shall be clean, dry and free of any material that may have an adverse effect on the bonding and/ or seal of the sealant and gasket materials.

Apply sealants and gasket under the conditions recommended by the manufacturer(s) Prime all surface to receive sealants and gasket unless recommended otherwise use no sealant that has started to set in its container or a sealant that has exceeded the self life published by the manufacturer.

Fill all joints continuously and completely with sealant forming a neat uniform concave bead. Finish the material flush with adjoining surfaces unless otherwise shown on the drawings. All sealant surfaces shall be tooled smooth.

i) Samples

Contractor shall submit samples for review, labeled samples on 300mm long sections of aluminium extrusion shapes. Samples must show extremes of colour texture variation. Samples will be reviewed by Engineer-in-charge for colour and texture only. Compliance with other requirements shall be the responsibility of the Contractor. Colour and texture range of production material shall match approved samples. The Engineer-in-charge shall also require samples which will show the fabrication techniques and workmanship of the component parts, and the design of accessories and other exposed auxiliary items, before fabrication of the work proceeds.

17.0 ALUMINIUM WORKS

a) The aluminium work shall comprise for doors, windows, ventilators and partitions with extruded built up standard tubular sections / appropriate Z sections and other sections of approved make conforming to IS: 733 and IS : 1285, fixed with rawl plugs and screws or with fixing clips, or with expansion hold fasteners including necessary filling up of gaps at junctions, at top, bottom and sides with required PVC / neoprene felt etc. Aluminium sections shall be smooth,rust free, straight, mitred and jointed mechanically wherever required including cleat angle, Aluminium snap beading for glazing / paneling, C.P. brass / stainless steel screws, all complete as per architectural drawings and the directions of Engineer-in-charge.

b) The aluminium section shall be colour anodized by electro chemical process (as per IS 7088), 15 microns thickeness with lacquer coating to protect the anodized surface. The shade shall be as approved by the Engineer-in-charge

c) Fixing glazing shall be proviided in aluminium door, window, ventilator shutters and partitions etc. with PVC/ neoprene gasket etc. complete as per the architectural drawings and the directions of engineer-incharge

d) The glazing shall be in reflective heat strengthened glass panes of 6.0 mm thickness of required shade as approved by Engineer-in-charge

18.0 STRUCTURAL STEEL

a.General

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

ii.Fabrication, erection and approval of steel structures shall be in compliance with General Specifications mentioned in CPWD specifications with up to date correction slips and IS: 800 – 1984. For the guidance on general fabrication and erection of structural steel work, Chapter 11 of IS: 800 (1984) must be followed. As far as safety is concerned guidance could be obtained from Indian safety code for structural steelwork IS: 7205(1974). Before the commencement of the erection, all the erection equipment tools, shackles, ropes etc. should be tested for their load carrying capacity. Such tests if needed may be repeated at intermediate stages also.

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

b.Scope

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

c.Fabrication Drawings

i.The contractor shall prepare all fabrication and erection drawings on the basis of approved design drawings and shall submit the same in triplicate to the Engineer-in-charge for review, Engineer-in-charge shall review and comment, if any, on the same. Such review, if any, by the Engineer-in-charge, does not relieve the contractor of any of his required guarantees and responsibilities. The contractor shall however be responsible to fabricate the structural strictly conforming to specifications and reviewed drawings.

ii.Fabrication drawings shall include but not limited to the following:

·Member sizes and details

·Types and dimensions of welds and bolts

·Shapes and sizes of edge preparation for welding

·Details of shop and field joints included in assemblies.

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

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

·Calculations when asked for approval.

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

iv.Any alternate design of change in section is allowed when approved in writing by EIC

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

vi.Engineer-in-charge review shall not absolve the contractor of his responsibility for the correctness of dimensions, adequacy of details and connections. One copy will be returned reviewed with or without comments to the contractor for necessary action. In the former case further three copies of amended drawings shall be submitted by the contractor for final review.

vii. The contractor shall supply three prints each of the final reviewed drawings to the Engineer-in-charge within a week since final review.

viii. The Project Manager will verify the correct interpretation of their requirements

ix.If any modification is necessary in the approved drawing during the course of execution of the job, revised fabrication drawings will be prepared by the contractor, incorporating the changes and the revised fabrication drawings shall be duly got reviewed as per the above Clauses.

d.Materials

i.Rolled Sections

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

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

ii.Welding Materials

Welding electrodes shall conform to IS: 814 and approval of welding procedures shall be as per IS: 823.

iii. Bolts, Nuts & Washers

Bolts and nuts shall be as per IS: 1367 and tested as per IS: 1608. It shall have a minimum tensile strength of 44 Kg/mm2 and minimum elongation of 23% on a gauge length of 5.65 (A- Original cross sectional area of the gauge length). Washers shall be as per IS: 2016.

iv.All materials shall conform to their respective specifications. The use of equivalent or higher grade or alternate materials will be considered only in very special cases subject to the approval of the Engineer-in-charge in writing.

v.Receipt& Storing of Materials

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

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

·Structural with surface defects such as pitting, cracks, laminations etc. shall be rejected if the defects exceed the allowable tolerances specified in relevant standards or as directed by the chief Engineer-in-charge.

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

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

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

·The contractor may use alternative materials as compared to design specification only with the written approval of the Engineer-in-charge.

vi.Material Tests

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

·Whenever quality certificates are missing or incomplete or when material quality differs from standard specifications the contractor shall conduct all appropriate tests as directed by the Engineer-in-charge at no extra cost.

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

vii.Fabrication

The Contractor will submit the credential with full particulars about work completed by fabricator to be deployed for this work for approval of Engineer-in-charge. After written approval is communicated in respect of fabricator, then only the jobs should be asigned to him. Fabrication shall be in accordance with IS: 800 Section V in addition to the following:

·Fabrication shall be done as per approved fabrication drawings adhering strictly to work points and work lines on the same. The connections shall be welded or bolted as per design drawings. Work shall also include fabricating built up sections.
·Any defective material used shall be replaced by the contractor at his own expense, care being taken to prevent any damage to the structure during removal.

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

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

a.Preparation of Materials
Prior to release for fabrication, all rolled sections warped beyond allowable limit shall be pressed or rolled straight and freed from twists, taking care that an uniform pressure is applied.
Minor warping, corrugations etc. in rolled sections shall be rectified by cold working. The sections shall be straightened by hot working where the Engineer-in-charge so direct and shall cooled slowly after straightening.
Warped members like plates and flats may be used as such only if wave like deformation does not exceed L/1000 but limited to 10 mm (L- Length).
Surface of members that are to be jointed by lap or fillet welding or bolting shall be even so that there is no gap between overlapping surfaces.

b.Marking
Marking of members shall be made on horizontal pads, of an appropriate racks or supports in order to ensure horizontal and straight placement of such members. Marking accuracy shall be at least + 1 mm.

c.Cutting

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

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

No electric metal arc cutting shall be allowed. All edges cut by oxyacetylene process shall be cleaned of impurities prior to assembly.

Cutting tolerances shall be as follows:

·For members connected at both ends + 1 mm.

·Elsewhere + 3 mm.
The edge preparation for welding of members more than 12 mm thick shall be done by flame cutting and grinding. Cut faces shall not have cracks or be rough. Edge preparation shall be as per IS : 823 - 1964.

d.Drilling

Bolts holes shall be drilled.

Drilling shall be made to the diameter specified in drawings.

No enlarging of holes filling, by mandrolling or oxyacetylene flame shall be allowed.

Allowed variations for holes (out-of-roundness, eccentricity, plumb-line deviation) shall be as per IS: 800.

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

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

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

f.Welding:

i)Preparation of Members for Welding

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

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

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

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

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

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

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

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

·The elements shall be got checked and approved by the Project Manager or their authorised representative before assembly.

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

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

ii)Assembly of structural members

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

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

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

Generally no special edge preparation shall be required for members under 8 mm thick. Edge preparation (beveling) denotes cutting of the same so as to result in V, X K or U seam shapes as per **IS: 823**.

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

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

The elements shall be got checked and approved by the Engineer-in-charge or their authorized representative before assembly.

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

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

iii) Welding procedures

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

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

The steel structures shall be automatically, semi-automatically or manually welded as per direction of Engineer-in-charge.

Welding shall begin only after the checks mentioned in relevant clause have been carried out.

The welder shall mark with his identification mark on each element welded by him. When welding is carried out in open air, steps shall be taken to protect the face of welding against wind or rain. The electrodes, wire and parts being welded shall be dry.

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

For continuing the welding of seems discontinued due to some reason, the end of the discontinued seem shall be melted in order to obtain a good continuity. Before

resuming the welding operation, the groove as well as the adjacent parts shall be well cleaned for a length of approx. 50 mm.

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

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

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

The order and method of welding shall be so that -

-No unacceptable deformation appears in the welded parts.

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

The defects in welds must be rectified according to IS: 823 and as per instruction of Engineer-in-charge.

iv)Weld Inspection

The weld seams shall satisfy the following:

-shall correspond to design shapes and dimensions.

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

During the welding operation and approval of finished elements, inspections and tests shall be made as shown in annexure-B. The mechanical characteristics of the welded joints shall be as in IS: 823.

v)Preparation of Members for Bolting

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

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

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

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

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

Before assembly, the members shall be checked and got approved by the Engineer-in-charge.

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

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

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

vi)Bolting up

Final bolting of the members shall be done after the defects have been rectified and approval of joints obtained. The bolts shall be tightened starting from the centre of joint towards the edge.

vii)Planing of Ends

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

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

The following tolerances shall be permitted on member that has been planed.

-On the length of the member having both ends planed, maximum + 2 mm with respect to design.

-Level differences of planed surfaces, maximum 0.3 mm.

-Deviation between planed surface and member's axis maximum 1/1500.

viii)Holes for Field Joints

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

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

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

The tolerance for spacing of holes shall be + 1 mm.

ix)Tolerances

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

x)Marking for Identification

All elements and members prior to dispatch from the fabrication yard for erection shall be shop marked.

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

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

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

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

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

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

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

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

xi)Shop Test Pre-assembly
For steel structures that have the same type of welding the shop test pre- assembly shall be performed on one out of every 10 members minimum.
For bolted steel structures, shop test pre-assembly is mandatory for all elements as well as for the entire structure in conformity with previous Clause.

g.Shop Inspection and Approval

i)General
The Engineer-in-charge or their representative shall have free access at all responsible times to the contractor‘s fabrication shop and shall be afforded all reasonable facilities for satisfying himself that the fabrication is being undertaken in accordance with drawings and specifications.
Technical approval of the steel structure in the shop by the Engineer-in-charge is mandatory.
The contractor shall not limit the number and kinds of tests, final as well as intermediate once, or extra tests required by the Engineer-in-charge.
The contractor shall furnish necessary tools, gauges, instruments etc. and technical non-technical personnel for shop tests by the Engineer-in-charge, free of cost.

Shop Acceptance The Engineer-in-charge shall inspect and approve at the following stages:

The following approvals may be given in shop:

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

Final approvals Intermediate approval of work shall be given when a part of the work is preformed later: Cannot be inspected later Inspection would be difficult to perform and results would not be satisfactory.

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

Approval of materials Approval of field joints Approval of parts with planed surfaces Test erection Approval of members Approval of markings Inspections and approvals of special features, like Rollers, loading platform mechanism etc.
During the partial approval, intermediate approvals as well as all former approvals, shall be taken in to consideration.

Final approval in the Shop

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

Partial approvals Approval of shop primer coat Approval of mode of loading and transport

Approval of storage (for materials stored)

Painting and Delivery

Preparation of parts for shop painting: Painting shall consist of providing at least one coat of red oxide zinc chromate primer to steel members before dispatch from shop. Primer coat shall not be applied unless:

Surface have been wire brushed, cleaned of dust, oil, rust or sand blasted as per the requirement and direction of Engineer-in-charge etc.

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

The surface to be painted is completely dry.

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

Members and parts have been inspected and accepted

Welds have been accepted.
The following are not to be painted or protected by any other product:

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

Surfaces bearing markings

Other surfaces indicated in the design.
The following shall be given a coat of hot oil or any approved resistant lubricant only.

Planed surfaces

Holes for links

The surfaces that are to be embedded or in contact with the concrete shall be given a coat of cement wash. The surfaces which are in contact with the ground, gravel or brick work and subject to moisture shall be given bituminous coat. The other surfaces shall be given a primer coating.

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

The contractor shall paint further coats of red-oxide after erection and placing in position of the steel structures as directed by the Engineer-in- Charge.

ii)Packing, transportation, delivery

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

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

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

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

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

If certain parts cannot be transported in the lengths stipulated in the design, the position and type of additional splice joints shall be approved by the Engineer-in-charge.

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

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

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

The parts shall be delivered in the order stipulated by the Engineer-in-charge and shall be accompanied by document showing:

-Quality and quantity of structure or members

-Position of member in the structure

-Particulars of structure

-Identification number job symbol.

h.Field Erection

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

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

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

·Approval by the Engineer-in-charge or their representatives at any stage of work does not relieve the contractor of any of his required guarantees of the contract.

·Storage and preparation of parts prior to erection

The storage place for steel parts shall be prepared in advance and got approved by the Engineer-in-charge before the steel structures start arriving from the hop. A platform shall be provided by the Contractor near the erection site for preliminary erection work. The contractor shall make the following verifications upon receipt of material at site.

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

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

For the above work sufficient space must be allotted in the storage area which will be arranged by the contractor without any extra cost to the department.

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

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

The parts shall be stored according to construction symbol and markings so that these may be taken out in order or erection.
The parts shall be at least 150 mm clear from ground on wooden or steel blocks for protection against direct contact with ground and to permit drainage of water.
If rectification of members like straightening etc. are required, these shall be done in a special place allotted which shall be adequately equipped.
The parts shall be clean when delivered for erection.

i.Erection& Tolerances

Erection in general shall be carried out as required and approved by the Engineer-in-charge. Positioning and levelling of the structure, alignment and plumbing of the stanchion and fixing every member of the structure shall be in accordance with the relevant drawings and to the complete satisfaction of the Engineer-in-charge.
The following checks and inspection shall be carried out before during and after erection.

-damage during transportation

-accuracy of alignment of structures

-erection according to drawings and specifications

-progress and workmanship.

In case there may be any deviations regarding positions of foundations or anchor bolts, which would lead to erection deviations, the Engineer-in-charge shall be informed immediately. Minor rectifications in foundations, orientation of bolts holes etc. shall be carried out as part of the work, at no extra cost.
The various parts of the steel structure shall be so erected so to ensure stability against inherent weight, wind and erection stresses.
The structure shall be anchored and final erection joints completed after plan and elevation positions of the structural members have been verified with corresponding drawings and approved by the Engineer-in- charge.
The bolted joints shall be tightened so that the entire surface of the bolt heads and nuts shall rest on the member. For parts with sloping surfaces tapered washers shall be used.

j.Final acceptance and handing over the structure

(i)At acceptance, the contractor shall submit the following documents:

-Shop and erection drawings

-four sets soft copy and hard copies 4 copies of each of the following:

•Shop acceptance documents quality certificate for structurals, plates, etc. (electrodes, welding wire, bolts, nuts, washers etc.)

•List of certified welders who worked on erection of structures.

•Acceptance and intermediate control procedure of erection operations.

(ii)Approval by the Engineer-in-charge at any stage of work does not relieve the contractor of any of his required guarantees of the contract.

k.Grouting of Pockets

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

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

l.Tolerances allowed in the erection of building without cranes

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

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

Contractor to submit shop drawing for all structural steel work for approval. The work at site should commence only after getting the shop approved.

Contractor to get erection scheme approved before commencement of erection of trusses.

19.0 WATER PROOFINGTREATMENT:

All the items for water proofing treatment with cement based water proofing treatment for roof slab and sunken portion in schedule of quantities shall be guaranteed for TEN YEARS the case of cement based treatment by the contractor as per Performa prescribed. The water proofing treatment work should be got done through specialized agency approved by EIC.

WATER PROOFING TREATMENT FOR ROOF

- Water proofing treatment for roof/ sunken floor has to carried out as per the respective Bill of Quantities/ CPWD Specification.
- The finished surface after water proofing treatment shall have required slope.
- While treatment of sunken floors is done it shall be ensured that the 'S' or 'P' traps as the case may be have been fixed/ eased and rounded off properly the work shall be carried out as per relevant CPWD specifications.

WATER PROOFING FOR SUNKEN SLABS

The work shall be got executed from the specialized agency as approved by the Engineer-in-charge.

Contractor shall also submit the names of water proofing specialist along with information about their technical capabilities and list of similar works executed by the specialized agency in the past for the approval of Engineer-in-charge.

Total quantity of the water proofing compound required shall be arranged only after obtaining the prior approval of the make by Engineer-in-charge in writing. Materials shall be kept under lock and key and proper account of the water proofing compound used in the work shall be maintained. It shall be ensured that the consumption of the compound is as per specified requirements.

The finished surface after water proofing treatment shall have adequate smooth slope as per the direction of the Engineer-in-charge.

Before commencement of treatment on any surface, it shall be ensured that the outlet drain pipes / spouts have been fixed and the spout openings have been eased and rounded off properly for easy flow of water.

The approved specialized agency for the work of water proofing will have to execute a guarantee bond in prescribed Proforma for removing any defects for at least 10 years. Guarantee bond shall be signed by both the specialized agencies as approved by the Engineer-in-charge and the contractor to meet their liability under the guarantee bond. However, the sole responsibility about the efficiency of water proofing treatment shall rest with the contractor.

Polycarbonate Sheet

The Glazing/Glass shall be vision glass panels (IGUs) comprisingof hermetically-sealed 6-12- 6 mm insulated glass (double glazed) vision panelunits of size and shape as required and specified, comprising of an outer heatstrengthened float glass 6mm thick, of approved colour and shade with
reflective soft coating on surface # 2 of approved colour and shade, an innerHeat strengthened clear float glass 6mm thick, spacer tube 12mm wide,dessicants, including primary seal and secondary seal (structural siliconesealant) etc. all complete for the required performances, as per the Architecturaldrawings, as per the approved shop drawings, as specified and as directedby the Engineer-in-Charge. The IGUs shall be assembled in the factory/workshop of the glass processor.
Coloured tinted float glass 6mm thick substrate with reflective soft coatingon face # 2, + 12mm Airgap + 6mm Heat Strengthened clear Glass of approvedmake having properties as visible Light transmittance (VLT) of 25 to 35 %,Light reflection internal 10 to 15%, light reflection external 10 to 20 %, shading coefficient (0.25- 0.28) and U value of 3.0 to 3.3 W/m2 degree K etc. Theproperties of performance glass shall be decided by technical sanctioningauthority as per the site requirement.

20.0 SIGNAGE AND ASSOCIATED WORKS

1. The Biohazard, Chemical Hazard, Radiation hazard etc. signages shall be appropriately displayed.
2. The sign boards for rooms and area display shall be in English language
3. Suitable pictogram to be provided as per approved samples
4. The colour of signages to be as approved by Engineer-in-charge.
5. All signages details including sizes of sheet, letters, pictogram and border allround to be submitted and got approved from ENgineer-in-charge.
6. The signages work shall be for all heights and floor levels.
7. The scope of work include providing and fixing base frame with removable/ interchangeable signages.

a) PVC sheet / sun board

1. Sheet to be best available brand of minimum thickness 3mm.
2. Top vinyl film to be best available brands of LG, Samsung or equivalent.
3. The thickness of film without adhesive to be around 75 microns and with adhesive to be 100 microns.
4. The fixing to be done with screws / hanging chains/pipes/rods of approved make & material as per discretion of Engineer.
5. The work shall include pictogram & fixing up to any floor and height, wall fixing or hanging on ceiling.

b) Stainless steel

1. The thickness of sheet to be minimum 16 G for plate sign board and 18/20 G for SS letters.
2. The same to be fixed with SS screws.
3. The engraving of letters to be as per standard norms and colours.
4. The individual alphabets/ letters, wherever required to have an inbuilt arrangement for fixing to support base with stainless steel screws complete for all heights and levels. All corners to be smoothly finished & SS welding.
5. The sheet/letters may be shining or mat finish as approved by engineer-in-charge.

PLUMBING WORKS

19.1 Work under this section shall consist of furnishing all labour, materials, equipment and appliances necessary and required to completely furnish all the Plumbing and other specialized services as described hereinafter and as specified /or shown on the Drawings

19.2 Without restricting to the generality of the foregoing Sanitary installations shall include the following:

a) Sanitary Fixtures & CP Fittings
b) Soil, Waste, Rain Water and Vent Pipes.
c) Internal and External Water Supply System
d) Water distribution system from plant room to various locations
e) Internal and External Sewerage and Storm water drainage system
h) Rain water harvesting system with recharge well.

19.3 All works specified in the specification have to be executed in accordance with:

a) The latest CPWD specifications, wherever applicable.
b) The rules and regulations of Local Authority Having Jurisdiction, and as per the statutory regulations applicable.
c) Applicable norms laid down by the relevant sections of latest editions of National Building Code (NBC) and all relevant codes of Bureau of Indian Standards shall be followed, as applicable.

d) The codes of the Uniform Plumbing Code of India shall be used as a general guide for good engineering practice, design and workmanship norms.

19.4 All materials used in the works shall have Bureau of Indian Standards valid certification stamped, marked or cast on the material in an acceptable and approved manner, as specified hereinafter.

19.5 Drawings issued are schematic and indicate the concept. Contractor shall make his shop drawings on basis of Architectural and Tender drawings issued by the Engineer-In-Charge. Work will be executed only as per approved shop drawings, to be submitted by the contractor and approved by Engineer-in-charge

19.6 Licence and Permit

a) Contractor must keep constant liaison with all relevant authorities and shall be responsible for obtaining all approvals relating to water supply, sewerage, storm-water drainage system including rainwater harvesting complete.

b) Contractor shall obtain, from the local authorities all related completion certificates with respect to his work as required for occupation of the building

19.7 Cutting & Making Good

No structural member shall be chased or cut without the written permission of the Engineer-In- Charge.

19.8 Final Installation

The Contractor shall install all sanitary fixtures and fittings in their final position in accordance with the approved trial assemblies and as shown on the Drawings. The installation shall be complete with all supply and waste connections. The connection between building and piping system and the sanitary fixtures shall be through proper unions and flanges to facilitate removal / replacement of Sanitary Fixtures without disturbing the built in piping system. All unions and flanges shall match in appearance with other exposed fittings.

Fixtures shall be mounted rigid, plumb and true to alignment. The outlet of water closet pans and similar appliances shall be examined to ensure that outlet ends are butting and the receiving pipes before making the joint. It shall be ensured that the receiving pipes are clear of obstruction. When Fixtures are being mounted, attention shall be paid to the possibility of movement and settlement by other causes. Overflows shall be made to ensure that necessary anchoring devices have been provided for supporting water closets, wash basins, sinks and other appliances

19.9 Protection against Damage

The Contractor shall take every precaution to protect all Sanitary fixtures against damage, misuse, cracking, staining, breakage and pilferage by providing proper wrapping and locking arrangement till the completion of the installation and handling over. At the time of handling over, the Contractor shall clean, disinfect and polish all the fixtures and fittings. Any Fixtures found damped, cracked, clipped, strained or scratched shall be removed and new fixtures and fittings free from defects shall be installed

19.10 **Sanitary Fixtures**

a) The work in general shall be carried out as per CPWD Specifications with up to date correction slips.

b) 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.

c) Whether specifically mentioned or not all Fixtures and appliances shall be provided with all fixing devices, nuts, bolts, screws, hangers as required

19.10.1 EUROPEAN W.C.

a) European-type wall-hung WC with seat, lid and low level flushing PVC cistern, health faucet etc. 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/bolts as per approval of the Engineer-In-Charge.

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

19.10.2 SINKS

a) Sinks shall be of stainless steel (lab sinks) and vitrouschina in toilets

b) 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 40 mm dia C.P. waste with chain and plug or P.V.C. waste. Fixing shall be done as directed by Engineer-In-Charge.

NOTE : All sinks in BSL-3, BSL-2 and Animal Facility shall be in Stainless Steel 304, with hands free/elbow operated tap.

19.10.3 ACCESSORIES

a) Contractor shall install all Chromium Plated and porcelain accessories as shown on the drawings or as directed by Engineer-In-Charge,

b) All C.P. Accessories shall be fixed with C.P. brass half round head screws and cup washers in wall with raw plugs or nylon sleeves and shall include cutting and making good as required or as directed by Engineer-In-Charge.

c) Tower rail of SS grade 316, Mirror with frame of PVC or superior material & Glass shelf supported on SS Brackets, Toilet paper holder of SS grade 316 with European WC,Soap rack shall be provided in Toilets

19.11 SOIL, WASTE & VENT PIPES

i) GENERAL

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

a) Vertical and horizontal Soil, Waste and Vent Pipes, Rainwater Pipes and Fittings, Joints Clamps and connections to Fixtures.

b) Connection of pipes to Gully Traps & Manholes etc.

ii) a) All materials shall be new of the best quality conforming to specifications and subject to the approval of Engineer-In-Charge.

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

c) 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.

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

e) Access doors for fittings and cleanouts shall be so located that they are easily accessible for repair and maintenance.

f) All works shall be executed as directed by Engineer-In-Charge.

iii) UPVC Pipes (I.S. 13592)

a) 4/6/10 kg/cm2 Class selection shall be as required/specified. All fittings for uPVC pipes up to 200 mm O.D. size shall be injections moulded as per manufacturer, confirming to IS: 13592 and as specified.

b) For Fittings of sizes which are not injection moulded but fabricated (Locally/ Imported) sample of the same shall be submitted for approval.

iv) Clamps & Structural Support

a) G.I. clamps shall be of standard design and fabricated from M.S. flat 40x3mm thick with required Galvanization.

b) Where G.I. clamps are to be fixed on RCC columns or slotted angles, walls or beam they shall be fixed with 40x3mm flat iron "U" type clamps with anchor fasteners of approved design or 6mm nuts and bolts.

c) Structural clamps shall be fabricated from G.I. (Galvanized) Structural members e.g. rods, angles, channels flats as per detailed drawing or as directed. Contractor shall provide all nuts, bolts, welding material and paint the clamps with one coat of red oxide and two or more coats of black Enamel paint. Wooden saddles, where required shall be provided.

d) Slotted angle/channel supports on walls shall be provided. Angles/channels shall be of sizes as per good engineering practice. Angles/channels shall be fixed to brick walls with bolts embedded in cement concrete blocks and to RCC walls with suitable anchor fasteners. The spacing of support bolts horizontally shall not exceed 1 m.

e) Wherever G.I. clamps are required to be anchored directly to brick walls, concrete slabs, beams or columns for clamping arrangement and making good with cement concrete 1:2:4 mix (1 cement: 2 coarse sand: 4 stone aggregate 20mm nominal size) as directed by the Engineer-In-Charge.

v) Traps

Floor traps in labs shall be of stainless steel, deep seal with an effective seal of 100 mm. The UPVC trap and waste pipes shall be set in cement concrete blocks firmly supported on the structural floor. The blocks shall be in 1:2:4 mix (1 cement: 2 coarse sand: 4 stone aggregate 20 mm nominal size) and extended to 40 mm below finished floor level. Contractor shall provide all necessary shuttering and centering for the blocks. Size of the block shall be 30x30 cm of the required depth. Where traps are suspended below ceilings, they shall be provided with proper structural supporting arrangements

vi) Urinal Traps

Urinal traps shall be of UPVC deep seal traps or as specified with or without Vent and set in cement concrete block or suspended below ceiling.

vii) Stainless Steel Gratings

Floor and Urinal Traps shall be provided with 100-150 mm square or round Stainless steel grating, with rim of approved design and shape. Minimum thickness shall be 4- 5 mm.

viii) Cleanout Plus

Contractor shall provide brass cleanout plugs as required. Cleanout plugs shall be threaded and provided with key holes for opening. Cleanout plugs shall be fixed to the pipe by a male threaded adaptor.

ix) Inspection

Work should be inspected during installation and tests applied on completion, care being taken that, all work which is to be encased for concealed is tested before it is finally enclosed. Inspection should be carried out to ensure the following:

(a) Work accords with the drawing and specifications.
(b) All pipe brackets, clips etc. are securely fixed.
(c) Fixtures are correctly spaced.
(d) Pipe is protected where necessary.
(e) Embedded pipe work is properly protected before sealing-in
(f) All access covers, caps or plugs.
· Are accessible
· Are so made that the internal faces truly complete in internal bore.
· Cause no obstruction in the pipe bore
· Are well joined.

x) Testing

The soil, waste piping system and rain water should be tested after installation as follows:

a WATER TEST

The pipes shall be tested after installation & before the appliances are connected, preferably in sections so as to limit the static head of 4.5m. The pipe shall be filled with water for at least 10 minutes. After filling, pipes shall be struck with a hammer and inspected for blow holes and cracks. Then it will be necessary to seal all openings and leaks at joints immediately as observed during the test and all defective pipes shall be rejected and removed from the site.

b SMOKE TEST

Alternatively, the Contractor may test all Soil, Waste and Rainwater stacks by smoke testing machine. The smoke test shall be carried out as under:

Smoke shall be pumped into the stack after plugging all inlets and connections at the lowest points from a smoke testing machine which consists of a bellow & burner. The material usually burnt is greasy cotton waste which gives out a clear pungent smoke which is easily detected by sight as well as by smell, if there is leak at any points of the pipe. The top end shall however be left open. The stack shall then be observed for leakiness and all defective pipes and fittings removed or repaired as directed by the Engineer-In-Charge.

A test register shall be maintained and all entries shall be signed and dated by Contractors and Engineer-In-Charge.

19.12 WATER SUPPLY PIPING

i) 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 as per approved drawings

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

(a) All water lines to different parts of building and making connection from source etc. (b) Pipe protection and painting.
(c) Control valves, masonry chambers and other appurtenances.
(d) Connections to all toilets, sinks, equipment's, storage tanks and appliances.
(e) Excavation and refilling of pipe trenches, wherever required
(f) Trenches for taking pipe lines wherever required.

iii) General Requirements

a) All materials shall be new of the best quality conforming to specifications. All works executed shall be to the satisfaction of the Engineer-In-Charge.
b) Pipes and Fittings shall be fixed truly vertical, horizontal or in slopes as required in a neat workmanlike manner.
c) Short or Long bends shall be used on all main pipe lines as far as possible. Use of Elbows shall be restricted for short connections. As far as possible all Bends shall be formed by means of a hydraulic pipe bending machine for pipes up to 65mm dia.
d) 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.
e) Pipes shall be securely fixed to walls and ceilings by suitable clamps at intervals specified.
f) Valves and other appurtenances shall be so located as to provide easy accessibility for operations, maintenance and repairs.

iv) Piping Material

BSL-3 LABORATORY :

a) The water supply piping inside BSL-3 Laboratory shall be provided in AISI 304 conforming to JIS G3448 standards.
b) The OD, thickness and bore of pipes shall be as under:

	Outer Dia/Thickness	Nominal Bore
SS PIPE Grade 304	15.88 / 0.8 mm	15 mm
SS PIPE Grade 304	22.22 / 1.0 mm	20 mm
SS PIPE Grade 304	28.58 / 1.0 mm	25 mm
SS PIPE Grade 304	34 / 1.2 mm	32 mm
SS PIPE Grade 304	42.7 / 1.2 mm	40 mm
SS PIPE Grade 304	48.6 / 1.2 mm	50 mm

c) The fittings for SS 304 piping shall conform to JWWA G116 standards
d) The SS 304 piping system shall be capable for pressure upto 12 bar
e) All the joints iin the SS 304 piping system shall be press-fit type and O-ring/gaskets shall be in EPDM

f) All clamps, supports in walls and ceiling inside the high containment areas shall be in SS 304.
g) The pipe installation shall not be installed flushed on wall and shall be projected with minimum 1.5-2.0 inch gap from the wall to enable cleaning of pipe surface.
h) After installation, the entire pipeline system shall be pressure tested at 10 bar to ensure that there are no leakages.
i) Suitable back-flow prevention devices/valves shall be provided in the the pipeline system at appropriate locations to prevent any back-flow from BSL-3 Laboratory.

GENERAL AREAS :

Water supply system in BSL-2 Laboratory and Animal Facility shall be done in CPVC piping. In general areas, GI heavy class piping shall be provided. The GI pipe and fittings shall conform to IS:1239 and CPVC pipes and fittings shall conform to IS:15778

The Galvanizing shall conform to IS:4736, the zinc coating shall be uniform, adherent reasonably smooth and free from such imperfections as flux, ash and drop inclusions, bare patches, black spots, pimples, lumpiness, runs, rust strains, bulky white deposits and blisters. The pipes and sockets shall be cleanly finished, well galvanized in and out and free from cracks, surface flaws laminations and other defects. All screw threads shall be clean and well cut. The ends shall be cut cleanly and square with the axis of the pipe.

Galvanized iron pipes shall be jointed with threaded and socket joints, using threaded fittings. Pipes will be made by applying suitable grade of TEFLON tape used for drinking water supply. (Use of red or white lead and sutli will not be permitted for screwed joints). All pipes shall be fixed in accordance with layout and alignment as per approved drawings. Care shall be taken to avoid air pocket. Pipes aid underground shall be provided with anticorrosive protection, approved by Engineer-in-charge

v) Clamps

G.I. pipes in shafts and other locations shall be supported by M.S. clamps of design approved by Engineer-In-Charge. Pipe in wall chases shall be anchored by iron hooks. Pipes at ceiling level shall be supported on structural clamps fabricated from M.S. structural as described in the sub section. Pipes in typical shafts shall be supported on Slotted Angles/Channels as specified elsewhere

vi) Unions

Contractor shall provide adequate number of unions on all pipes to enable dismantling later. Unions shall be provided near each Gunmetal Valve, Stop Cocks, or Check Valves and on straight runs as necessary at appropriate locations as required and/or directed by Engineer-in- Charge.

vii) Gunmetal Valve

(a) Valves 65mm dia and below shall be heavy Gunmetal. Ball valves shall be tested at manufacturer's works and the same stamped on it.

(b) All Valves shall be approved by the Engineer-In-Charge before they are allowed to be used on work.

viii) Ball Valve

Ball Valves have body material as Forged Brass Chrome plated with Spindle Brass Nickel Plating & Lever handle Steel Chrome plated with green plastic cover. The valve is suitable for

water maximum working pressure up to 25 bar (PN 25). The valve is operated by turning. The rotation from open to close is a quarter turn (90°) which closes in a clock- wise direction.

ix) Butterfly Valve

(a) Butterfly valves of approved quality for pressure rating of 230 P.S.I. with locking arrangement and gearbox with handle operated (for above 150mm dia) shall be provided or as specified.
(b) Butterfly valves shall be of specified quality conforming to IS:13095
(c) Joints for butterfly valves shall be made with suitable tail /socket pieces on the pipe line and flanged joints made with 3mm thick insertion rubber gasket with appropriate number of bolts, nuts and washers
d) Butterfly valves shall be provided on all branches as shown in the approved drawings or as required

x) Non Return Valve

Non-return valves shall be of Cast Iron body and Bronze/Gunmetal seat. They shall conform to class of IS: 5312 with pressure rating PN 1.6 and have flanged ends. They shall be swing check type in horizontal runs and lift check type in vertical runs of piping. They shall not be spring-loaded type. An arrow mark in the direction of flow shall be marked on the body of the valve

xi) Air Release Valve

(a) Air release valves shall be single acting type air valves with cast iron body and bronze/gunmetal internal parts and plastic float.

(b) Each air release valve shall be provided with isolating ball valve of specification given above

xii) Testing

(a) All pipes, fittings and valves shall be tested by hydrostatic pressure of min. 1.5 times, the working pressure and subject to minimum of 7 kg/cm2 in any case and with the consent of Engineer-In-Charge.
(b) Pressure shall be maintained for a period of at least two hours without appreciable drop in the pressure after fixing at site. (+10 %). A test register shall be maintained and all entries shall be signed and dated by Contractor(s) and Engineer-In-Charge.
(c) In addition to the sectional testing carried out during the construction, Contractor shall test the entire installation after connections to the overhead tanks or pumping system or mains. He shall rectify all leakages, and shall replace all defective materials in the system. Any damage done due to carelessness, open or burst pipes or failure of fittings, to the building, furniture and Fixtures shall be made good during the defects liability period.
(d) After completion of the water supply system, Contractor shall test each valve by closing and opening it a number of times to observe if it is working efficiently. Valves which do not effectively operate shall be replaced by new ones and the same shall be tested as above.

xiii) Disinfection

After the first flushing, commercial bleaching powder is to be added to achieve a dosage of 2 to 3 mg/l of water in the system added and flushed. This operation should be performed twice to ensure that the system is fully disinfected and usable

19.13 SEWERAGE AND DRAINAGE PIPING AND WORKS

i) Work under this section shall consist of furnishing all Labour, Materials, Equipment's and Appliances necessary and required to completely finish Sewerage and Drainage system as required by the drawings, specified hereinafter and approved drawings.

ii) Without restricting to the generality of the foregoing, the sewerage system shall include:-

(a) Installation of all sewer lines / effluent lines
(b) Installation of all storm water drainage lines
(c) Construction of all catch basins, chambers, manholes & other related works
(d) Rain water harvesting system

iii) General Requirements

a) All materials shall be new of the best quality conforming to specifications and subject to the approval of the Engineer-In-Charge.
b) Drainage lines shall be laid to the required gradients and profiles.
c) All drainage work shall be done in accordance with the local Municipal bye laws.
d) Location of all manholes, catch basins etc., shall be got confirmed by the Contractor from the Engineer-In-Charge before the actual execution of work at site.
e) All works shall be executed as directed by Engineer-In-Charge

iv) 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 Engineer-In-Charge from time to time to meet the requirements of the works. No change 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 Engineer-In-Charge.

v) Drain piping in BSL-2 and Animal Laboratory shall be provided in UPVC Pipes, conforming to I.S. 13592.

a) 10 kg/cm2 Class selection shall be as required/specified. All fittings for uPVC pipes up to 200 mm O.D. size shall be injections moulded as per manufacturer, confirming to IS: 13592 and as specified.
b) For Fittings of sizes which are not injection moulded but fabricated, sample of the same shall be submitted for approval.

vi) All underground storm water drainage pipes and sewer lines where specified shall be centrifugally spun RCC (NP-2) pipes. 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. For road crossing NP-3 grade shall be used

vii) 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 12mm below the invert level of the pipe properly placed on the soil to prevent any disturbance. The pipe shall than 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 Engineer-In-Charge

viii) After setting out the pipes the collars shall be centered over the joint 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 degree to the longitudinal axis of the pipe on both side of the collars neatly.

ix) Fittings & Inspection Chambers

Cleanout plugs shall be provided on head of each drain and at location indicated on plans or directed by Engineer-In-Charge. Cleanout plugs shall be of size matching the full bore of the pipe.

x) Cement Concrete for Pipe Support

a) Wherever specified, all pipes shall be supported in concrete bed all round or in haunches.

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

Details for Cement Concrete

Description	**Upto 3 M depth**
Pipes in open ground (No sub soil water)	All round (1:5:10)
Pipes (all) in sub soil water condition	All round (1:3:6)
Pipes under the building or at road crossing or under public places	All round (1:2:4)

(1=1=1 cement, 2-3-5 coarse sand, 4-6-10) stone aggregate 20 mm nominal size)

c) R.C.C. pipes may be supported on brick masonry or precast R.C.C or Cast in situ cradles.
d) Pipes in loose soil or above ground shall be supported on brick or RCC anchor blocks.

xi) Manholes and Chambers

All manholes, chambers and other such works shall conform to CPWD specifications

xii) Testing

a) The lengths of sewer and drain shall be fully tested for water tightness.
b) The Contractor shall give a smoke test to the drains and sewer, if directed by the Engineer-In- Charge
c) A test register shall be maintained which shall be signed and dated by Contractor, Engineer-In- Charge

xiii) Drain Piping in BSL-3 Laboratory.

a) Drain piping in BSL-3 Laboratory shall be done in seamless welded stainless steel 316 pipes and shall be terminated to the Biological Liquid Effluent Decontamination Plant.
b) All welded joints in pipeline shall be provided with anti-rust treatment
c) The floor trap assembly shall be deep seal type in stainless steel and shall be grouted cat-in-situ and sealed with non-shrinking epoxy sealant
d) The selection of fittings and assemblies shall be done considering the effects of steam/condensate from the autoclaves and corrosion effects of decontamination chemicals.

e) Proper slope shall be maintained in the drain lines and appropriate non-return valve shall be provided to prevent backflow.
f) U-Traps shall be provided with suitable head to counter the high negative room pressure inside the laboratory.

20.0 FIRE FIGHTING WORKS

20.1 Work under this sub-head consists of furnishing all Labour, Material, equipment and accessories necessary and required to completely install the Fire Fighting System and equipment etc., as per National Building Code (NBC).

20.2 Without restricting to the generality of the foregoing, the work of Fire Fighting System shall include the followings:

a) Providing M.S. black steel pressure pipe line main including Valves, Fire Hydrants, Excavation for Pipes, Laying of pipes, Painting of pipe and Making Connection to supply system.
b) Black Steel Pipe, Mains Laterals, Branches, Valves Hangers and Appurtenances.
c) Hose Reels, Rubberized fabric lined hose pipes, Hose cabinets & Landing Valves.
d) Portable Fire Extinguishers.
e) Hydrants & related accessories).
f) All civil and structural works, electrics, control & instrumentation, site & shop painting for fire fighting system

Note : The existing Fire Hydrant shall be extended to provide Fire Fighting system in BSL-3 Laboratory building as per statutory requirement. The scope shall include providing and completion of fire fighting works in BSL-3 Laboratory building, complete as applicable and required.

20.3 Applicable / Reference Codes

a) IS:1239 (Part 1 & 2) - M.S. Pipe Heavy duty
b) IS:14846 Sluice valves (PN 1.6)
c) IS:6392-1971 - Steel Pipe Flanges
d) IS:554 - Pipe threads where pressure tight joints are required
e) IS:909 - U/G fire hydrants, sluice valve type
f) IS:5312 (P-1) - NRV
g) IS:778 - Gunmetal fullway valves with wheel tested to 20kg/cm2 class II
h) Butterfly valves - IS:13095 or BS:5155
i) IS:5290 - Internal hydrant shall comprise “Single Headed Single Outlet GM Landing Valve” conforming to Type A
j) IS:12585 - Hose tubing (Thermoplastic)
k) IS:884 - Hose tubing, Globe valve, Stop cock & Nozzle
l) IS:636 - Hose pipes rubber lined woven jacketed (RRL) & 63mm dia, conforming to type “A”
m) IS:903 - The couplings shall be of instantaneous [Branch pipe, nozzle, spring lock type Coupling etc.]
n) IS:15683 - Portable fire extinguishers

20.4 Drawings & Technical Submittal

The Contractor shall submit shop drawings for the entire fire fighting system installations to be provided under this contract along with details of General Arrangement drawings for major equipment’s for Fire Hydrant and Sprinkler Systems for approval of Engineer-in-charge before

proceeding with the work. He shall also furnish all clarifications and explanations as may be desired by the Engineer-in-charge promptly for early finalization of the shop drawings. The work to be executed as per approved shop drawings & technical submittal by the contractor

20.5 Approval by Local Fire Service

It shall be the responsibility of the contractor to get the approval from the Local fire Service as required. This shall be without any liability to the Engineer-In-Charge.

20.6 Piping

a) All piping shall be heavy class black steel conforming to IS: 1239 unless otherwise stated. Pipes shall be given one primary coat of red oxide paint before being installed.

b) All Fittings shall be new and from reputed manufacturers, Fittings shall be of malleable castings of pressure ratings suitable for the piping system. Fittings used on welded piping shall be of the weld-able type.

c) Flanges shall be new and from standard manufacturer as per IS:6392- 1971, Table 17 with appropriate number of G.I. Washers, Nuts and Bolts, half threaded with 3 mm insertion neoprene gasket complete

d) Tee off connection shall be through reducing tees, wherever possible. Otherwise ferrules welded to the main pipe shall be used. Drilling and tapping of the walls of the main pipe shall not be resorted to.

20.7 Welding

All welded piping is subject to the approval of the Engineer-In-Charge. Sufficient number of flanges and unions shall be provided.

Welding Procedures IS: 823
Welding Electrodes IS: 814, but of approved makes only

20.8 Pipe Installation and Support

i) Piping shall be properly supported on or suspended from stands, clamps, hangers etc., as specified and as required. The contractor shall adequately design all the brackets, saddles, clamps, hangers etc. and be responsible for their structural integrity. Shop Drawings of all supports to be submitted for approval before execution of work

ii) Pipe supports shall be of steel, adjustable for height and primer coated with rust preventive paint and finish coated black. Where pipe and clamp are of dissimilar material, a gasket shall be provided in between. Spacing of pipe supports on main headers shall not exceed 3.0 meters in any case, and additional supports shall be provided on all bends, tees, valves etc. as per requirements.

iii) Vertical risers shall be parallel to walls and column lines and shall be straight and plumb.

iv) Risers passing from floor to floor shall be supported at each floor by clamps or collars attached to pipe and with a 12mm thick rubber pad or any other approved resilient material. Where pipes pass through the terrace floor, suitable curbing shall be provided to prevent water leakage. Risers shall also have a suitable concrete pipe support at the lowest point.

v) Pipe sleeves of 50mm larger diameter shall be provided wherever pipes pass through wall and the annular space filled with lead wool and finished with retaining rings

20.9 Flanges

Flanged joints wherever required and specified in approved shop drawings shall be provided:

i) Flanges shall be as per I.S.6392-1971, Table 17/18 with appropriate number of G.I. Washers, Nuts and Bolts, half threaded with 3 mm insertion neoprene gasket complete.

ii) For jointing all types of flanged valves, vessels appurtenances, pumps, connections with other type of pipes, to water tanks and other places necessary and required as good for engineering practice

20.10 Pipe Protection

i) All pipes above ground and in exposed locations shall be painted with one coat of Red Oxide Primer immediately after bringing the pipes to site and shall be painted with one coat of red oxide primer after erection and proper hydraulic testing, and two or more coats of Synthetic Enamel Paint of approved shade.

ii) All black steel pipes under floors or below ground shall be provided with protection against corrosion after proper hydraulic testing by application of 100mm wide and 4mm thick layer of anti-corrosive protection tape over the pipe, with overlap of 25mm minimum as per manufacturers specifications.

iii) Where pipes are buried under ground, after treated, the same shall be back filled with the excavated soil. The top of the pipes shall not be less than 100cms below the ground level. Where this is not possible, the permission of Engineer-In-Charge shall be obtained for burying the pipes at lesser depth.

iv) Vibration Elimination: Piping installation shall be carried out with vibration elimination fittings wherever required.

20.11 Testing

All piping shall be tested to hydrostatic test pressure of minimum 14 kg/cm² or 1.5 times the design pressure whichever is higher for a period of not less than 24 hours. All leaks and defects in joints revealed during the testing shall be rectified to the satisfaction of the Engineer-In-Charge

20.12 Painting

i) After the piping has been installed, tested and run for at least ten days. The piping shall be given two finish coats, 3 mils each of approved colour

ii) The direction of flow of fluid in the pipes shall be visibly marked in white arrows or as directed by the Engineer-In-Charge.

20.13 Valves & Accessories

i) **Sluice / Gate Valves**

Sluice Valves above 65 mm shall be of Cast Iron body and Gunmetal seat. They shall conform to type PN 1.6 of IS:780. Sluice valves upto 65mm shall be of Gunmetal Full way Valve with

wheel tested to 20 Kg./cm2 class-II as per I.S: 778. Valve wheels shall be of right hand type and have an arrow head engraved or cast thereon showing the direction for turning open and closing.

ii) **Butterfly Valves**

a) The Butterfly Valve shall be suitable for waterworks. The Valves conforming to IS:13095 shall be provided. All valves shall be suitable to withstand the pressure in the system and rating shall be PN 1.6. All valves shall be right handed (i.e. handle or key shall be rotated clock wise to close the valve).

b) The direction of opening and closing shall be marked and an open / shut indicator fitted.

c) The material of valves shall be as under :-
Body – Cast iron
Disc – Ductile Iron
Seat – EPDM / Nitrile rubber
Shaft – Stainless Steel

d) 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

iii) **Non Return Valve**

Non-return valves shall be of Cast Iron body and Stainless Steel seat. They shall conform to API-594 and have companion flanges. They shall be Dual Plate Type suitable for both horizontal and vertical installation. An arrow mark in the direction of flow shall be marked on the body of the valve.

iv) **Air Release Valve**

Air valves shall be provided at all high points in the piping system for venting valves shall be of the double float type, with G.M. body, vulcanite balls, rubber sealing, etc. Air valves shall be of the sizes specified and shall be associated with an equal size forged ball valve.

v) **Ball Valve**

a) The Ball Valve shall be made from forged brass and tested to 20 Kg/ cm² pressure. The valve shall be internally threaded to receive pipe connections.
b) 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.
c) 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 / cm² pressure.
d) The handle shall also be provided with a lug to keep the movement of the ball valve within 90 degree.

vi) **Suction Strainer**

Strainers shall be of approved type with fabricated steel bodies designed to the test pressure of 16 Kg/ cm². Strainers shall be fabricated by minimum 1.2 mm thick stainless steel sheet with 3 mm dia. perforation holes. Strainers shall be provided with flanges or threaded sockets as required. They shall be designed so as to enable blowing out accumulated dirt and facilitate removal and replacement of screen without disconnection of the main pipe

vii) **Pressure Gauges**

Pressure gauges shall be of 150mm dia. dial and of appropriate range and be complete with shut off gauge valve etc. duly calibrated before installation. Care shall be taken to protect pressure gauges during pressure testing.

viii) **Flexible Connection for Pumps**

All suction and delivery lines shall be provided with double flanged reinforced neoprene flexible pipe connectors. Connectors should be suitable for a working pressure of each pump. Length of the connector shall be as per manufacturer's details

20.14 **Internal Hydrant**

The Single headed Internal Hydrant outlet shall be as per IS: 5290 (Type-A),

a) A cap with chain is provided on the head of the outlet. The hydrant will have an instantaneous pattern female coupling for connecting to Hose Pipe.

b) The Landing Valve shall be fitted to a Tee connection on the wet riser at the landing.

c) The Hydrant shall be constructed from gun metal and finished to a smooth polish on screwed ends. The Hydrant shall have screwed inlet of 80mm dia. flanged type with 4 nos. holes. The Hydrant shall have a PVC plug with chain fixed to the main body of the Hydrant. The Hydrant shall be tested to minimum 20 kg / cm² test pressure. The Hydrant shall not leak at any screwed joint

20.15 **First Aid Hose Reel Equipment**

First aid hose reel equipment shall comprise reel, drum which can swing upto 170 degrees, with hose, guide fixing wall bracket, hose tubing, globe valve, stopcock and nozzle. This shall conform to IS: 884 - 1969. The hose tubing shall confirm to IS: 444-1980 or IS:12585 (Thermoplastic). The drum shall be fabricated from GI sheet of minimum 18 gauge thickness.

a) The hose tubing shall be 20 mm dia and 36.50 m long, or as specified in the The G.M. nozzle 5mm and shutoff valve shall be of 25 mm size to shut off the water supply to the Hose Reel.

b) The fixing bracket shall be of swinging type. Operating instructions shall be engraved on the assembly. This heavy duty mild steel and cast iron brackets shall be conforming to IS:884 - 1969. The first-aid hose reel shall be connected directly to the M.S. pipe riser through a 25mm dia pipe.

c) MS bracket shall be fixed on the wall to which the first aid hose reel shall be bolted. The bracket shall be of 40x40x5mm thick MS angle to form a square of 400x400 mm approx. This shall be fixed on the wall. After approval of sample by Engineer-In- Charge further units shall be fabricated in factory and all joints shall be finished with grinder and shall be spray painted after single coat of primer.

20.16 Hose Pipes, Branch, Pipes & Nozzles

i) Hose Pipes

a) Two numbers Hose Pipes for Single headed External and Internal hydrants shall be rubber lined woven jacketed (RRL) and 63mm in dia. 15m long, (non percolating Reinforced rubber lined) conforming to IS:636 (Type A),. The hose shall be sufficiently flexible and capable of being rolled.

b) Each run of hose shall be complete with necessary Male & Female Gun Metal coupling at the ends to match with the landing valve or with another run of hose pipe or with branch pipe. The couplings shall be of instantaneous spring lock type. This shall be conforming to IS: 903

ii) Branch Pipes

Standard short sized Branch pipe shall be constructed from alloy of Gunmetal material, 63 mm dia and be complete with male instantaneous spring lock type coupling for connection to the hose pipe. The branch pipe shall be externally threaded to receive the nozzle conforming to IS:903. The branch pipe shall to be tested to 20 kg/ cm2 pressure.

iii) Nozzles

a) The nozzle shall be of Gunmetal, 20 mm internal diameter. The screw threads at the inlet connection shall match with the threading on the branch pipe. The inlet end shall have a hexagonal head to facilitate screwing of the nozzle on to the branch pipe with nozzle spanner.

b) End Couplings, Branch pipe, and Nozzles shall conform to IS:903 - 1985.

20.17 Orifice Plate

a) The internal hose cabinet shall accommodate the Hose Pipes, Branch Pipe, Nozzle and Hydrant Outlets and shall be fabricated from FRP. The overall size shall be 2100x1200x900 mm, or as specified in the Architectural details. This shall have lockable centre opening glazed doors/glass front door of min. 6 mm thickness as per the requirement and as per Architectural details. Where the niche for wet riser is provided with shutters, separate hose cabinet as above may be dispensed with. Sample of the fire door shall be approved by Engineer-In-Charge.

b) The hose cabinet shall be of colour / shade as approved by Engineer-In-Charge.

20.18 HOSE CABINET (INTERNAL)

a) The internal hose cabinet shall accommodate the Hose Pipes, Branch Pipe, Nozzle and Hydrant Outlets and shall be fabricated from FRP. The overall size shall be as specified in the drawing. This shall have lockable centre opening glazed doors/glass front door of min. 6 mm thickness as per the requirement and as per drawings. Where the niche for wet riser is provided with shutters, separate hose cabinet as above may be dispensed with. Sample of the fire door shall be approved by Engineer-In-Charge.

b) The hose cabinet shall be of colour/shade as per statutory requirement and as approved by Engineer-In-Charge

20.19 FIRE BRIGADE INLET CONNECTIONS

i) Fire Brigade Inlet connection shall be provided near the pump house and to the external fire ring system as specified , for the following purposes :-

(a) Fire Brigade suction draw out connection for fire static tank with provision of foot valve.

(b) Fire brigade inlet connection to fire static tank.

(c) Fire brigade inlet connection to the external ring main. Each connection shall be in accordance with similar dia of Sluice valve and Non return valve.

ii) The locations of the fire brigade connections shall be easily accessible to the fire brigade, without any possible hindrance and shall be as approved by the Engineer-in-Charge.

20.20 VALVE CHAMBER

Contractor shall provide suitable Brick Masonry Chamber in cement mortar 1:4 (1 cement: 4 coarse sand) on cement concrete foundations 150 mm thick in 1:5:10 mix (1 cement: 5 fine sand: 10 graded stone aggregate 40 mm nominal size) 12 mm thick plaster inside and outside finished with a floating coat of neat cement inside with cast iron surface box approved by fire brigade including excavation, back filling complete

20.21 PORTABLE FIRE ENTINGUISHERS

Portable fire extinguishers shall be provided and shall conform to IS:15683 and distribution of extinguishers in each building shall be in conformity with IS:2190 - 2010

i) **ABC Type Dry Powder Extinguisher**

a) The Extinguisher shall be filled with ABC Grade 40, Mono Ammonium Phosphate (MAP base) from approved manufacturer.

b) The Capacity of the extinguisher when filled with Dry Chemical Powder (First filling) as per IS:4308, Part-II-8/IS:15683, shall be 6 kg _/-2 % or 10 _/-3 %.

c) It shall be operated upright, with a squeeze grip valve to control discharge. The plunger neck shall have a safety city, fitted with a pin, to prevent accidental discharge. It shall be pressurized with Dry Nitrogen, as expelling. The Nitrogen to be charged at a pressure of 15 kg / cm².

d) Body shall be of mild steel conforming to relevant IS Standards. The neck ring shall be also mild steel and welded to the body. The discharge valve body shall be forged brass or leaded bronze, while the spindle, spring and siphon tube shall be of brass. The nozzle shall be of brass, while the hose shall be of braided nylon. The body shall be cylindrical in shape, with the dish and dome welded to it. Sufficient space for Nitrogen gas shall be provided inside the body, above the powder filling.

e) The Neck ring shall be externally threaded the threading portion being 1.6 cm. The filler opening in the neck ring shall not less than 50 mm. Discharge nozzles shall be screwed to the hose. The design of the nozzle shall meet the performance requirement, so as to

discharge at least 85 % of contents upto a throw of 4 meters, continuously, at least for 15 seconds. The hose, forming part of discharge nozzle, shall be 500 mm long, with 10 mm dia internally for 6 kg capacity and 12 mm for 10 kg capacity. It shall have a pressure gauge fitted to the valve assembly or the cylinder to indicate pressure available inside. The extinguisher shall be treated with anti-corrosive paint, and it shall be labelled with words ABC 2.5 cm long, within a triangle of 5 cm on each face. The extinguisher body and valve assembly shall withstand internal pressure of 30 kg / cm² for a minimum period of 2 minutes. The pressure Gauge shall be imported and suited for the purpose.

ii) **Carbon Dioxide Extinguisher**

a) The Carbon Dioxide Extinguisher shall be as per IS: 15683.

b) The Body shall be constructed of seamless tube conforming to IS: 7285, and having a convex dome and flat base. Its dia shall be maximum 140 mm, and the overlay height shall not exceed 720 mm.

c) The discharge mechanism shall be through a control valve conforming to IS: 3224. The internal siphon tube shall be of copper or aluminium conforming to relevant specifications.

d) Hose pipe shall be high pressure braided Rubber hose with a minimum burst pressure of 140 kg/cm², and shall be approximately 1.0 meters in length having internal dia of 10 mm. The discharge horn shall be of high quality unbreakable plastic with gradually expanding shape, to convert liquid carbon dioxide into gas form. The handgrip of Discharge horn shall be insulated with Rubber of appropriate thickness.

e) The gas shall be conforming to IS: 307 and shall be stored at about 85 kg/cm². The expansion ratio between stored liquid carbon dioxide to expanded gas shall be 1:9 times and total discharge time shall be minimum 10 sec. and Maximum 25 sec.

f) The extinguisher shall fulfil the following test pressures :-
Cylinder : 236 kg/cm²
Control Valve : 125 kg/cm²
Burst pressure of Hose : 140 kg/cm² minimum.

g) It shall be an upright type. The cylinder, including the control valve and high pressure Discharge Hose must comply with relevant Statutory Regulations and be approved by Chief Controller of Explosives, Nagpur and also bear IS marking.

h) The Extinguisher including components shall be ISI Mark.

20.22 COMMISSIONING AND TESTING

After satisfactory completion of installation of Fire Fighting system, the Contractor shall provide all facilities including necessary piping, labour, tools and equipment's etc. for carrying out testing and commissioning of the fire fighting system complete as per requirement in the presence of Engineer-In-Charge or his representative and during the visit of the Fire Officer whenever and as may be required. Generally, the following test/inspection has to be carried out:

(i) For the automatic operation of the fire system and pumps
(ii) For checking the Pressure available at the farthest and highest point in fire wet riser/down comer system.

25.0 WATER TREATMENT PLANT

a) GENERAL

The scope of work shall include:

- Water treatment plant equipment and accessories
- Water supply pumps
- Piping, valves and accessories
- All incidental jobs connected with Water Treatment Plant system services installation such as cutting chases in brick and making good, cutting/ drilling holes through walls, floors and grouting for fixing of fixtures, equipment foundation, Structural supports & other supports as required at site shall be part of Water Treatment Plant system works.
- Cleaning of all equipment and piping including flushing of all pipe work to remove any foreign matter shall be carried out in sections as the work progresses
- Contractor shall submit the samples/catalogues of each material/equipment giving technical data. Contractor shall place the order only after getting written approval of samples/catalogues from Engineer-in-charge
- Contractor shall temporarily cover & protect all equipments & open pipe ends etc. It is the responsibility of the Contractor to protect all the installed fittings and all equipments until the time of testing, commissioning & handing over to the owners
- The location of the Water Treatment Plant System pipe lines, indicated in the drawing is only indicative. The contractor shall submit the shop drawing for the approval of Engineer-in-charge before executions of the installations at site
- Testing & commissioning of all systems including submission of test reports.

b) PUMPS

MONOBLOCK PUMP

Water supply pumps shall be suitable for clean filtered water. Pumps shall be single/multi stage, monobloc horizontal, centrifugal pumps with CI casing and Bronze impeller, Carbon steel Shaft, mechanical seal and coupled to a TEFC electric motor. Each pump should operate to a curve required by the operating conditions.

The MOC shall be CI casing, Bronze impeller & Carbon steel shaft.

All parts in contact with water shall be corrosion resistant material Each pump shall be provided with a totally enclosed fan cooled induction motor of suitable H.P. The motors shall be suitable for 400/440 volts, 3 phase, 50 cycles A.C. power supply and shall conform to IS 325 operating at 2900 RPM nominal speed

Each pumping set shall be provided with 150 mm dia gunmetal “Borden” type pressure gauge with ball valve and connected piping

Pump or the whole set shall be stable on rubber vibration eliminating pads appropriate for each pump as recommended by the manufacturer and approved by Engineer-in-charge
Contractor shall submit the technical data sheets, performance curve, GA/foundation drawing, installation drawing of all water supply pumps for approval of Engineer-in-charge.

SUBMERSIBLE PUMP FOR SUMP

Submersible pumps shall be single stage, single entry pump. Pump shall be with dynamically balanced impeller connected to a common shaft to the motor. Stuffing box shall be provided with mechanical seals.

Each pump shall be provided with water cooled squirrel cage induction motor suitable for 415 ± 10% volts, 3 phase, 50 cycles A.C. power supply.
Each pump shall be provided with liquid level controller for operating the pump between predetermined levels.

The pumping set shall be for stationary application and shall be provided with pump connector in it. The delivery pipe shall be joined to the pump through a rubber diaphragm, and bend and guide pipe for easy installation, without disturbing delivery pipe the pump unit shall have a back pull out design. A rust proof chain shall be provided for each pump.

Pump shall be provided with all accessories and devices necessary and required for the pump to make a complete working system.

c) LEVEL CONTROLLERS:

Level controllers shall be electronic low voltage type using required number of stainless steel type probes, shrouded in PVC sheath or encapsulated in a stainless steel pipe.

d) PIPE & FITTINGS

Water supply piping shall be in medium class GI conforming to IS 1239. Fittings shall be of malleable cast iron galvanized of approved make. Each fitting shall have manufacturer's trade mark stamped on it. Fittings for G.I pipes shall include couplings, bends, tees, reducers, nipples, unions, bushes etc. Fittings etc. shall conform to IS : 1879. (Part 1 to X) 1987.

Butterfly Valves

All valves 65 mm dia and above shall be C.I. slim seal butterfly valves. Butterfly valves shall be of best quality conforming to I.S. 13095 of class specified.

Non Retrun Valves (Check Valves)

Non-return valves shall be cast iron dual plate type with cast iron body and gunmetal internal parts conforming to IS: 5312

Ball Valves

All ball valves shall be heavy duty of approved make. Valves shall have suitable for test pressure of 25 Kg/Sqcm.

e) WATER TREATMENT PLANT

Contractor shall get the existing water quality tested and submit the technical data sheet of the proposed water treatment plant of dual media filter/activated carbon filter for the approval of Engineer-in-charge..

MULTIGRADE PRESSURE SAND FILTER/ACTIVIATED CARBON FILTER, WATER SOFTENER & BRINE TANK

Filter shall conform to the code of unfired pressure vessel conforming to I.S. 2825.
Filter shall be multigrade pressure sand filter/activated carbon filter may be altered to suite the design of the most efficient performance.

Filters shall be vertical type of required diameter or as per manufacturers standard design. The

shell and dished ends shall be fabricated from M.S. sheet. Tank suitable to with stand 1.5 times the working pressure. The shell shall have a minimum thickness of 6 mm and dished ends 8 mm or as per manufacturer recommendations.

Each filter shall have at least one pressure tight manhole cover for inspection and repairs.

Each filter shall be provided with screwed or flanged connections for inlet, outlet individual drain connections and all face piping, valves and all other connections necessary and required. Face piping shall be MS / GI. (Heavy Duty).

f) Pipe protection

Where specified, required or approved all pipes in chase below ground shall be protected against corrosion by applying two coats of bitumen paint and wrapping with polythene tape and finishing with one more coat of bitumen paint.

g) Pipe Support

Piping shall be properly supported on or suspended from clamps, hangers as specified and as required. The contractor shall adequately proviide all the brackets, saddles, anchors, clamps and hangers and be responsible for their structural sufficiency.

Pipe supports shall be of steel, adjustable for height and primer coated with rust preventive paint and finish coated back. Where pipe and clamps are of dissimilar materials a gasket shall be provided in between

h) Vertical risers shall be parallel to walls and column lines and shall be straight and plumb. Risers passing from floor to floor shall be supported at each floor by clamps or collars steel structural supports attached to pipe and with a 15 mm thick rubber pad or any resilient material. Where pipes pass through the terrace floor, suitable flashing shall be provided to prevent water leakage. Risers shall have a suitable clean out at the lowest point and air vent at the highest point

i) The work shall be complete in all respect and shall include starter panel for pump motors, cabling and wiring connection, earthing etc. as required

SECTION - II

TECHNICAL SPECIFICATIONS FOR ELECTRICAL & ASSOCIATED WORK

TECHNICAL SPECIFICATIONS – ELECTRICAL AND ASSOCIATED WORKS

1.0 CONDUIT SYSTEM, CABLE TRAY, CABLE LADDER AND TRUNKING

Work Description

This section describes the supply and installation of wiring facilities systems include conduits, cable trays, cable ladder and Trunking system, c/w associated fittings and accessories.

All cables running above the suspended false ceiling, columns, or on surface shall be supported by proper clamps, on cable tray or cable ladder system. No free hanging of cable is allowed.

The cable routes shown in the drawings shall be used as a guide only. The cable routes may be physically examined and coordinated with other services before undertaking the installation work in hand.

Uncoordinated and inaccessible routes after other services are installed, shall be relocated at the expense of the Contractor.

All conduits, trunking, cable trays and cable ladders shall be earthed in accordance to IS: 4043.

Standards

The complete wiring facilities system shall be manufactured, supplied, installed and tested in accordance with the latest revision of the Indian standards and the appropriate BS / IEC include:

1.	Steel Conduit and Fitting Accessories	IS:9537 (Part-II)/ BS4568 & BS731
2.	PVC Conduit and Fitting Accessories	IS-9537/1983 (Part-III)/BS6099 & BS4607
3.	Cable Tray	BS729
4.	Cable Ladder	BS729
5.	Cable Trunking	BS4678

The complete wiring facility system shall conform to the requirements of all relevant local codes, as applicable, together with the additional requirements referred to in the approved specification and drawings.

Submissions

The contractor shall submit shop drawings and technical submittals. The shop drawings and technical submissions shall be approved by the Engineer-in-charge prior to execution of works.

Steel Conduit and Accessories

Steel Conduit:

1. All conduits shall be of heavy gauge solid drawn ERW welded manufactured out of 16 (1.6mm) gauge MS Sheet up to 32mm dia and 14 (2 mm) gauge for sizes above 32mm.
2. Both inner and outer surfaces shall be smooth without burrs, dents and kinks.
3. Conduits shall be black stove enameled inside and outside. The cross section of conduit shall be uniform throughout.
4. The welding shall be uniform such that welded joints do not yield when subjected to flattening test. Welded joint shall not break when threaded or bent at an angle.
5. Conduit shall conform to specifications of IS: 9537 (Part-II) and the capacity of conduits shall be in accordance with the standards
6. The minimum size of the conduit shall be 19/20mm diameter.
7. Care shall be taken to ensure that all conduits are adequately protected while stored at site prior to erection and no damaged conduit is used.

Fittings

1. Samples of conduit fittings shall be submitted for approval prior to use on work.
2. Fittings shall be those intended for use with screwed conduits and shall comply with IS 9537. However, bends, elbows and tees shall not be installed.
3. Boxes and cover plates installed outdoors shall have fixing lugs exterior to the box so that fixing screws do not enter the box interior.
4. Adaptors used with flexible conduits shall conform to IS: 9537.

Circular Boxes

Circular boxes shall be of malleable cast iron, galvanized and of standard pattern with spout(s). When used for connecting lengths of conduits, circular boxes shall be provided with cover plates of similar make that are complete with brass fixing screws.

Rectangular Boxes

Rectangular boxes (adaptable boxes) shall be of mild steel not less than 2.4 mm gauge and galvanized. When used as junction boxes, lids of the same gauge with brass fixing screws shall be used.

Boxes for Accessories

Boxes for accessories shall be suitable for surface mounting or recessed mounting according to the requirements. Surface mounted boxes and accessories shall be metal clad pattern. Recessed boxes and accessories shall be complete with insulated molded type cover plates conforming to IS: 5133 Part I-1969.

Covers

All covers for boxes, etc shall be made of galvanized steel of 1.2mm thickness.

PVC Conduit and Accessories

PVC Conduit

1. All conduits shall be high impact rigid 2mm thickness PVC heavy duty type and shall comply with I.E.E. regulations for non-metallic conduit as per IS-9537/1983 (Part-III).
2. All sections of conduit and relevant boxes shall be properly cleaned and glued by using epoxy resin glue and the proper connecting pieces.

3. Inspection type conduit fittings such as inspection boxes, drawn boxes, fan boxes and outlet boxes shall be of M.S. or otherwise mentioned.
4. Conduit shall be terminated with adopter/PVC glands as required.

PVC Conduit Accessories

1. Accessories used for conduit wiring shall be of an approved type conforming to IS: 3837-1966.
2. All accessories used shall be of standard white or black color, identical to conduit used.
3. Plain conduits should be jointed by slip type of couplers with manufacturer's standard sealing cement.
4. All conduit entries to outlet boxes, trunking and switchgear are to be made with adaptors female thread and male bushes screwed.
5. PVC-switch and socket boxes with round knockouts are to be used. The colors of these boxes and the conduits shall be the same.
6. Standard PVC circular junction boxes are to be used with conduits for intersection, Tee-junction, angle-junction and terminal. For the drawing-in of cables, standard circular through boxes shall be used.
7. Samples of accessories shall be submitted for approval prior to installation.
8. All jointing of PVC conduits shall be by means of adhesive jointing. Adequate expansion joints shall be allowed to take up the expansion of PVC conduits.

Conduit Installation

Layout

1. The conduit layout and conduit routes shall be submitted for approval.
2. Conduit routes shall be chosen for easy, straight runs with minimum bends and crossings. Generally they shall follow the structure of building, running at right angles or in parallel to floors and ceilings. Conduits shall be kept within 300 mm of floors and ceilings when running parallel to them.
3. Outlet boxes for housing accessories shall be used as draw boxes. The total number of draw boxes shall be kept to a minimum and shall be provided so that conduit runs do not exceed 12 m or have more than two right angle bends.
4. All conduits shall be kept clear of gas and water pipes. In particular, conduits shall be at least 150 mm away from gas pipes. Where proximity to these pipes is unavoidable, they shall be effectively segregated e.g. using rubber or other insulating material to prevent appreciable voltage differences at possible points of contact. Segregation from extra low voltage circuits and telecommunication circuits shall also apply unless these are wired to the same voltage requirements as lighting and power circuits.
5. Conduits from different distribution boards shall not be connected to the same junction box. Each run of conduit shall be assembled complete with draw-in-wires.

Joints and Terminations

1. Electrical and mechanical continuity shall be maintained throughout all conduit joints and terminations. Conduit threads shall be thoroughly cleaned and tightly screwed. The conduit system shall be watertight after installation.
2. Conduits shall be connected using couples or via boxes. With a coupler, the ends of the conduit shall butt close together and the running coupler is screwed tightly on and tightened by a locknut.

3. Conduits terminating into boxes provided with spouts shall be threaded so that there are no exposed threads. For boxes with no spouts, the termination shall be made using a brass bush and a coupler. The conduit is pushed through the knockout or drilled entry and the bush is screwed tightly onto its end. The coupler is screwed to butt firmly against the exterior wall of the box.
4. Where conduits are not jointed or terminated in boxes, they shall be terminated in a screwed brass bush.
5. In all joints and terminations, conduit threads shall not be exposed. Where this cannot be avoided as in a running coupler, the exposed threads shall be coated with red lead paint to seal against the ingress of water.

Bends

1. Conduits shall only be bent cold with an approved type of bending block or bending machine, without altering the dimensions of their sections.
2. All conduit bends shall be such as to permit compliance to the requirements for bends in cables to as stated in the BS 7671.
3. Bends shall be made with as large a radius as the position of the conduit within the building permits. Where the bend is more than 90 degree, circular or rectangular junction boxes are to be used for connecting conduits.

Cabling

1. The conduit system must be installed free of obstructions and sharp corners before any cables are drawn in. Conduits shall be thoroughly swabbed to remove moisture and dirt immediately prior to the drawing in of cables.
2. Cables shall be drawn without crossing each other and shall not be pulled against the walls of the draw boxes. Slack cables shall left in all draw boxes.
3. Cables shall be continuous throughout conduit lengths and no joints are permitted. There shall be no kink in cables, neither any cut, abrasion or chink in the cable insulation.
4. The same conduit shall carry the lead and return conductors bunched together. However, the same conduit shall not house cables from different distribution boards.
5. Cables for power and lighting circuits and extra low voltage systems shall not be drawn into the same conduit. Lighting and power circuits shall run in separate conduits except, where an adopter box is employed as final distribution point, a number of final circuits are grouped together in larger conduits between the distribution board and the adopter box provided that all final circuits in one conduit are of the same phase. In the case of three phase circuits, all three phases including neutral, if any, shall be drawn into the same conduit.
6. Conduits shall not constitute the earth continuity path for the electrical circuit. A separate circuit protective conductor shall be installed within the conduit. The whole conduit system shall be effectively earthed.
7. Flexible conduits shall have a separate earthing conductor installed within the tubing and connected at conduit ends. Flexible conduits in general shall not be used for more than 3m length.
8. Maximum number of PVC insulated 650/1100V grade/copper conductor cable conforming to IS:694-1990

Access and Drainage

1. The conduit system shall be rewirable, that is, draw boxes must be accessible for the purpose. Where boxes are concealed, their covers shall be flushed with the finished surface.

2. The need for accessibility notwithstanding, the conduit system shall be protected against the ingress of water and impurities. When installed, conduits shall be kept dry and free of debris with approved pipe plugs or caps. Such plugging is especially essential prior to pouring concrete for concealed installation. As for boxes, they shall be covered by steel plates prior to concreting.
3. When installed outdoor, and in situations liable to condensation of moisture, conduits shall be arranged to be self draining, so that water may drain to low points which are fitted with a drain plug. Conduits laid under concrete floors shall have watertight floor-traps of approved detail for access of these drainage points.
4. Conduits run on surfaces other than structural steel members shall be secured using galvanized space bar saddles and brass fixing screws. Spacing of saddles shall not exceed 1.2 m for conduit sizes up to and including 25 mm and 1.8 m for sizes 32 mm and above.
5. Conduits run on structural steel shall be secured using girder clips or an approved clamp. These conduits and those run in the vicinity of structural steel shall be bonded to the steelwork using an efficient and permanent metallic connection. The conduits shall not in any way be under mechanical stress.
6. All conduit boxes except loop-in patterns shall be fixed direct to the building structure in addition to the support provided by the conduits.
7. Conduits terminating into surface boxes shall be secured by a minimum of 3 saddles at not less than 32 mm, 150 mm and 300 mm respectively from the box.
8. Conduits shall be painted with an approved paint to blend with visual environment. A zinc rich undercoat shall be provided before painting the final coat.

Cable Tray/ Cable Ladder

Cable Tray and Cable Ladder systems are intended for the support and accommodation of cables and possibly other Electrical equipment in electrical/instrumentation Communication systems.

The cable trays / ladders shall be fabricated according to the design specified by IEC 61537 and should be tested for Safe Working Load (SWL). The relevant details of SWL and the load chart with respect to SWL, supporting distance and the deflection should be according to the following chart.

Safe Working Load (SWL) with a span length up to 5 meters								
Description	Side Height (in mm)	Width (in mm)	Span length (in meters)					
			1.5m	2m	2.5m	3m	4m	5m
			Permitted Load (in kg/meter)					
Perforated tray	60	100-500	150	100	50	-	-	-
	85	100-500	175	110	50	-	-	-
	100	150-500	185	130	75	60	-	-
Cable Ladder	60	200 - 600		225	150	110	45	-
	110	200 - 600		310	-	140	65	50

Safe Working Load (SWL) with a span length up to 10 meters									
Description	Side Height (in mm)	Width (in mm)	Span length (in meters)						
			4m	5m	6m	7m	8m	9m	10m
			Permitted Load (in kg/meter)						

Perforated Cable Tray for long span distance	110	200 - 300	160	110	75	-	20	-	-
		400 - 600	200	150	100	-	40	-	-
	160	200 - 300	230	180	140	100	70	-	-
		400 - 600	250	200	160	130	100	-	-
Cable Ladder for long span distance	110	200 - 300	160	110	80	40	-	-	-
		400 - 600	210	150	100	70	-	-	-
	160	200 - 300	230	180	140	100	70	-	-
		400 - 600	250	200	160	130	100	-	-
	200	200 - 600	-	-	300	250	200	140	100

Fabrication of Tray / Ladder and accessories at site and welding is not permitted. In unavoidable circumstances, If any cut or holes are made in the trays/Ladder/accessories, zinc spray need to be applied over the surface. The metal edge has to be protected by edge protection sleeves to avoid cable damage. Edge of the supports has to be protected with plastic END caps. Screwed connections and internal fixing Devices should not create any damage to the cable when correctly fixed. Sudden or jerky motions shall not be used to tighten reusable screw connections.

Cable Tray:-

The cable tray and all accessories shall be fabricated from sheet steel and has to be galvanized against corrosion confirming to EN10346/ ISO1461-1999 for installations in indoor and outdoor applications respectively. The cable trays shall be supplied in standard lengths of 3000 mm and the width of the tray shall be as follows.
Width: 100, 150, 200, 300, 400, 500.

All the cable tray accessories like Bend's, TEES's, Cross over's etc. should be designed in accordance with IEC 61537 and shall be factory fabricated. The accessories shall be from the same material as of the tray and modular type, it should be connected with the trays by using fasteners. Typical details of trays, fittings and accessories.etc. are shown in the enclosed drawings.
For Cable trays designed, tested and confirming to IEC 61537, thickness of cable tray should be according to the manufacturer's catalogue. For locally fabricated and non-tested tray, thickness should be 2 mm up to span length of 1.5 meter, 2.5 mm for span length between 2 to 3 meter and 3 to 4 mm for span length between 4 and 10 meter

Cable ladder:-

The cable Ladder and all accessories shall be fabricated from sheet steel and has to be galvanized against corrosion confirming to EN10346/ ISO 1461-1999 for installations in indoor and outdoor applications respectively. The cable ladders shall be supplied in standard lengths of 3000 mm and the width of the ladder shall be as follows.
Width: 200 to 600 mm in multiples of 100 mm
Maximum rung spacing in the ladder shall be 300mm. The rung's should be made of C profiles suitable to fix cables by special metal clamps according to the drawing. The ladder shall be of riveted and foldable type for easy transportation and to avoid damage during transportation and storage. All the ladder accessories like Bend's, TEES's, Cross over's etc. should be designed in accordance with IEC 61537 and shall be factory fabricated . The accessories shall be made from the same material as of the ladder and modular type, it should be connected with the ladder by using fasteners. The details of ladders, fittings and accessories etc. are shown in the enclosed drawing.

For Cable Ladders designed, tested and confirming to IEC 61537, thickness of cable Ladder should be according to the manufacturer's catalogue. For locally fabricated and non-tested Ladder,

thickness should be 2.5 mm up to span length of 1.5 to 2 meter, 3 mm for span length between 2.5 to 4 meter and 3 to 4 mm for span length between 5 and 10 meter

Mounting Accessories (supports and Brackets):-

The mounting accessories shall be fabricated from steel and has to be hot dip galvanized against corrosion confirming to ISO 1461-1999 for installations in both indoor and outdoor applications and should be of completely modular type.

All supports and Brackets should be factory made, hot dip galvanized after completing welding, cutting, drilling, other machining operations and tested according to IEC 61537 according to the arrangements in the enclosed drawing. The system shall be designed such that it allows easy assembly at site by using Bolts and Nuts. The main support and brackets shall be fixed at site using necessary brackets, clamps, fittings, bolts, nuts and other hard ware etc to form various arrangements required to support the cable trays. Welding of the components at the site shall not be allowed.

Corrosion Protection:-

The cable tray/ ladder/accessories shall be Galvanized according to EN10346 / ISO 1461-1999 for installations indoor and corrosive outdoor applications respectively. Sample tray/ ladder/ accessories/ mounting accessories and supports should be salt spray tested according to ISO 9227 for > 150 hours & 500 hours. (*155 hours according to class 3 for pre-galvanized surface and 550 hours according to class 6 for Hot dip Galvanized surface as per ISO)

Testing and Certification:-
Cable tray / Ladder, bend, T Bend, cross, and all supports are to be tested for Safe Working Load (SWL), deflections, Impact resistance, Salt Spray & Electrical continuity test according to IEC 61537. The cable tray/ladder should not deflect more than 1/100th of the span length at SWL in Mid span and the transverse deflection of all mounting accessories at SWL shall not exceed 1/20th of the length. The cable tray/ cable ladder should be tested up to 1.7 times SWL at minimum and maximum room temperature. The temperature classification of cable tray system should be - 5 to + 150°C.

Cable Trunking

Cable trunking shall be manufactured from 1.6 mm minimum electro-galvanized mild sheet steel to BS4678 finished in oven-baked electro statically coated epoxy powder coating with color.
All trunking shall have removable lids extending over their entire lengths. Lids shall be fixed at interval not exceeding 1 meter by means of brass steel screws which and protected against corrosion by a finish of zinc coating or equivalent to zinc coating.
Factory-made bends, joints, elbow, riser, tee, reducer and accessories with same material shall be provided throughout the installation for trunking.
Trunking space factor shall be in compliance with latest IS standards.
Copper earth link bar shall be fixed at every joint of the cable trunking run.
Note: All items mentioned in this section shall be manufactured to comply with the specifications of National Electrical Code (NEC) and National Electrical Manufacturer's Association (NEMA).

2.0 WIRES AND CABLES

Work Description

The scope shall include supply, installation and testing of single core PVC FRLS insulated 1.1 KV grade stranded twisted wires shall comply with following standards with update amendments under the specifications.

- IS-3961: Current rating for cables.
- IS-5831: PVC insulation and sheath of electric cables.
- IS-694: PVC insulated cables for working voltage up to and including 1100 volts.
- IEC-54 (I): PVC insulated cable.

Copper/ Aluminum stranded twisted conductor PVC insulated wires shall be used in conduit. Aluminum wires for power cables and copper wires for control cables shall be used.
The wires shall be color coded - (red, yellow, blue) for Phases, black for Neutral and green for Earth.
Progressive automatic in line indelible, legible and sequential marking of grade, voltage, capacity and length in meters shall be embossed at every meter on the outer sheath of cable.
The manufacture, testing and supply of the cable under these specifications shall comply with following standards latest edition of:

- IS: 8130: Conductors for insulated electric cables and flexible cords.
- IS: 5831: HRPVC / HR PVC insulation and LSZH sheath of electric cables.
- IS: 3975: Mild steel wires, strips and tapes for armoring cables.
- IS: 3961: Current rating of cables.

The routing and minimum rated current carrying capacity of the LV power cables shall be indicated on the Drawing. The Contractor shall consider the manufacturer data and engineering for cable sizing and to ensure that it meets the conditions of grouping, ambient temperature etc.
All LT cables for normal power/control circuits within buildings shall be XLPE insulated and PVC sheathed Aluminum conductor and control cables shall be PVC insulated and PVC sheathed copper conductor respectively.
All LT cables, for emergency power circuits serving emergency light, Building Management System (BMS), Fire Protection System, Security Systems, emergency communication systems, and sump pump system and fire lifts etc. with back-up from UPS systems or incoming and outgoing from the Emergency Main Switchboard, shall be fire resistant as required.
Cables in service duct, open trench, direct-laid underground in soil shall be by means of armoured cables. Non-armoured cables shall only be laid in conduits, trunkings or tray/ladder for mechanical protection.

Standards

All cables shall be manufactured and constructed in accordance of the following standards with the latest revision:

1.	IS: 694	:	HRPVC/XLPE insulated (heavy duty) electric cables for working voltage up to and including 1100 volts.
2.	IS: 424-1475(F-3)	:	Power cable-flammability test.
3.	IS: 7098(I)	:	Specification for cross-linked polyethylene insulated LSZHPVC sheathed cable for working voltage up to 1.1 KV.
4.	IS: 1554	:	Specification for PVC insulated (heavy duty) electric cables for working voltages up to and including 1100 volts.

5.	ASTM-D: 2863	:	Standard method for measuring the minimum oxygen concentration to support candle-like combustion of plastics (Oxygen Index).
6.	ASTM-D: 2843	:	Standard test method for measuring the density of smoke from the burning or decomposition.
7.	IEEE: 383	:	Standard for type of tests Class-IE, Electric cables, field splices and connections for power generation station.
8.	ASTME: 662/ IEC: 754(x)	:	Standard test method for specific optical density of smoke generated by solid materials
9.	IS: 10418	:	Cable drums.
10	IS-10810	:	Testing method of cable.
11.	IS-6121	:	Cable glands.
12.	IS-9537	:	Rigid steel conduit.

The manufacturing of the cable shall also conform to the requirements of all relevant local codes, as applicable.

Submission

As a minimum requirement, the submission shall include the following:

1. Sample submission
2. Shop Drawings of the cable route showing the co-ordinated routing of cables, arrangement on cable trays, methods of fixing of cable trays and cables, etc. All conduits including concealed conduit routing drawings shall also be included
3. Cable test reports and IS Certification
4. Cable schedule indicate the following data include:
   a. Cable code and type and installation method
   b. Cable feed from and serve to
   c. Cable route length and voltage drop
   d. Cable capacity and
   e. Upstream protection breaker rating
   f. The cable schedule shall be prepared in accordance to the work requirement.

LT Cables

1. The cables shall be suitable for laying in racks, ducts, trenches conduits and under-ground buried installation with uncontrolled back fill and chances of flooding by water.
2. They shall be designed to withstand all mechanical, electrical and thermal stresses under steady state and transient operating condition.
3. The aluminum/ copper wires used for manufacturing the cables shall be true circular / sector in shape before stranding and shall be of uniformly good quality, free from defects. The conductor used in manufacture of the cable shall be of H2 grade.
4. The cable should withstand 2.5 kA for 1 Sec. with insulation armour insulated at one end. Bidder shall furnish calculation in support of capability to withstand the earth fault currents. The current carrying capacity of armour and screen (as applicable) shall not be less than the earth fault current values and duration.
5. The fillers and inner sheath shall be of non-hygroscopic fire retardant materials and shall be suitable for the operating temperature of the cable. Filler and inner sheath shall not stick to insulation and outer sheath.
6. Progressive automatic in line indelible, legible and sequential marking (grade, voltage, capacity, length - in meters) shall be embossed at every meter on the outer sheath of all cables and at every 5 meter ‘LSZH marking in case of ‘LSZH cables.

7. IS: 3975 method (b) for strip / wire armouring shall only be acceptable. For single core cable aluminium wire armouring shall be used.
8. Allowable tolerance on the overall diameter of the cables shall be + 2mm.
9. The normal current rating of all HRPVC/XLPE insulated cables shall be as per IS: 3961.
10. A distinct inner sheath shall be provided by pressure extrusion process for all multi cores armoured and unarmoured cables as per IS: 5831.
11. Outer sheath shall be provided by extrusion process as per IS: 5831.
12. The breaking load of armour joint shall not be less than 95% of that armour wire. Zinc rich paint shall be applied on armoured joint surface.
13. In plant repairs to the cables shall not be accepted.
14. All the cables shall be supplied in non-returnable drums as per IS: 10418.
15. Fire Survival Cables
    - Multi core Al / Cu Conductor XLPE/ Cross linkable Low Smoke Halogen Free insulated with Fire rated Glass Mica Tape, LSZH inner and outer Sheathed, Armoured with GI Strip/ Wire Fire Survival Cable.
    - Basic design shall be as per BS:7846-2009,
    - Fire resistance of the cable shall be as per BS:8491-2008 & 8434-2:2003

Inspection

All cables shall be inspected on receipt of the same at site and checked for any damage during transit.

Joints in Cables

Cable drum length and sizes of cable lengths required may be checked carefully before cutting the cables from drum. The contractor shall take care that the cables received at site are distributed to various locations in single length as far as possible to ensure maximum utilization. Where the joints are unavoidable, the same is to be done with approval from the Engineer-in-charge. The joints shall be done by qualified jointer strictly in accordance with manufacturer's instruction / drawings in presence of Engineer-in-charge.

Joint Boxes for Cables

The cable joint boxes shall be of appropriate size suitable for type of cable of particular voltage rating.

Cable Joints

1. All cable joints materials shall be of standard make and suitable to requirement. On jointing of cables in the joint box the cable compound shall be filled in accordance with manufacturer's instructions and in approved manner. All straight through joints shall be done in epoxy mould boxes with epoxy resins. Straight through joints shall not be permitted unless the length of run is in excess of cable drum.
2. End terminations of cables more than 1.1 KV grade shall be done with epoxy mould boxed and epoxy resin. Cable glands shall be 1.1KV grade double compression type and made to tin plated heavy-duty brass casting and machine finished. Glands shall be of robust construction capable of clamping cable and cable armour, firmly without injury of cable.
3. All washers and hardware shall be made of brass tinned. Rubber components used in the glands shall be made of neoprene of tested quality.
4. Cable lugs shall be tinned copper / aluminium solder less crimping type conforming to IS: 8309 suitable for aluminium or copper conductor.
5. Crimping of terminals shall be done by using Corrosion inhibitory compound, with crimping tool.

6. Fire resistant paint has to be applied 1 Meter on either side of cable joint.
7. The contractor shall liaise fully with all other contractors to achieve an efficient and properly coordinated installation where equipment has to be re-positioned due to lack of site liaison; no extra cost shall be incurred by the client.

Erection of Cables

Notwithstanding the cable routes indicated on the Drawings the Contractor shall be entirely responsible for the supply of correct lengths of the cables to be installed and for all allowances for connecting and terminating the cables to the switchgears and transformers respectively

The Contractor shall submit proposed cable routes including details of supports for the cables for approval before installation. The cable shall not be run in places other than corridor, passageway, electrical riser or other designated areas subject to the Engineer's approval. The support shall be deemed to be included in the Contract.

Cable Pulling

Winching of cables through ducts / pipes shall only be carried out with the approval of the Engineer-in-charge in which event a pulley eye shall be attached to the conductors. Cable shall be run in neat and orderly manner to allow space for future cabling and maintenance. Under any circumstances the cable shall not run diagonally across a room, cable basement, corridor, etc.

A cable sheath stocking may be employed or cables where no undue stress in the sheath is likely to occur.

Care shall be taken to ensure that the draw strain is applied to the armouring and protected during drawing against damage.

Cable Laying

The cable drum shall be placed on jacks before unwinding the cable. Great care shall be exercised in laying cables to avoid forming links. At all changes in directions in horizontal & vertical places, the cable shall be bent with a radius of bend not less than 8 times the diameter of cable.

The cable of 1.1KV grade shall be laid not less than 750mm below ground level in a 375 mm wide trench (throughout). Where more than one cable is to be laid in the same trench, the width of the trench shall be increased such that the inter axial spacing between the cables except where otherwise specified is at least 150mm minimum or as per site requirements or as approved by the Engineer-in-charge. Where single core cables are used in multiphase systems, the cables shall be installed in trefoil where possible.

In case the cables are laid in vertical formation due to unavoidable circumstance the depth per tier shall be increased by 200 mm (minimum). Cable shall be laid in reasonably straight line, where a change in direction takes place a suitable curvature shall be i.e. either 20 times the dia meter of the cable or the radius of the bend shall not be less than twice the diameter of the cable drum or whichever less is. Minimum 3 meter long loop shall be provided at both sides of every straight through joint & 3 meters at each end of cable or as directed at site.

Greater care shall be exercised in handling the cable in order to avoid forming 'Kinks'. The cable drum shall in-verbally convey on wheels and the cable unrolled in right direction as indicated on the drum by the manufacturer. The cable shall be pulled over rollers in the trench steadily and uniformly without jerks and strains.

Cables laid in trenches in single tier formation, 10 cms all-around sand cushioning is provided below and above the cable before a protective cover is laid. For every additional vertical tier. The 30 cm of sand cushion is provided over the initial tier. The cable shall be protected by 2nd class brick of size not less than 230 x 115 x 75mm, stone tiles/ RCC curved channel be placed on top of the sand breadth wise for the full length of the cable and where more than one cable is to be laid in

the same trench the brick shall cover all cables and project at least 8 cms over the outer sides of the end cables.

Filling of trenches shall be done after sand cushioning and tiles or bricks lying and inspection is carried out by the Engineer-in-charge (Refer drawing). Back fill for trenches shall be filled in layer not exceeding 150 mm. Each layer shall be properly rammed & consolidated before laying the next layer.

RCC pipe shall be provided on all road crossing. The size of the pipe shall be above the size of the cable. Minimum 100mm dia. pipes are to be provided. The pipe shall be laid in ground with special arrangement and shall be cement jointed and concreting of 1:5:10 shall be provided as per relevant IS with latest amendment. Nothing extra shall be paid on this account. Cable route markers at interval of 30 meters and at the point of direction change shall be provided to indicate cable path. Aluminum strip cable tag of 20mm wide with engraved tag no. shall be provided at both ends of cable.

Where the cables are laid in ducts (pucca trenches) inside the building, they will be laid on MS rack/ cable trays grouted on trenches walls. Cables passing through floors shall be protected from mechanical damage by steel channel to a height of one meter above the floor. Sleeve shall be provided in the wall for crossing of cables.

Where the cables are laid in open (in building) along walls, ceiling or above false-ceiling, cable rack (ladder type) or cable tray shall be provided. The size of the cable tray or rack shall depend on the number of cables to pass over that rack. Cable tray/rack shall be properly supported through wall/ceiling according to the site conditions. Cable laid on tray & riser shall be neatly dressed & clamped at an interval of 1000 mm & 750mm for horizontal & vertical cable run respectively either side at each bend of cable. All power cables shall be clamped individually & control cables shall be clamped in groups of three or four cables. Clamps for multi core cables shall be fabricated of 25x3 GI flats. Single core power cable shall be laid in trefoil formation & clamped with trefoil clamps made of PVC/fiber glass.

Cable openings in wall/floor shall be sealed by the contractor suitably by Hessian tape & Bitumen compound or by any other proven material to prevent ingress of water.

After the cables are laid, shall be tested as per IS and the results submitted to Architects/Engineer and in case the results found unsatisfactory, all the repairing/ replacing of cables will be done by the contractor free of charge.

Internal Wiring

All the wiring installation shall be as per IS: 732 with latest amendment. PVC insulated copper conductor cables as specified in bills of quantity shall be used for sub-circuit runs from the distribution boards to the points and pulled into conduits. They shall be twisted copper conductors with thermoplastic insulations of 1100 volts grade. Colour Code for wiring shall be followed.

Looping system of wiring shall be used, wires shall not be jointed. Where joints are unavoidable, they shall be made through approved mechanical connectors with prior permission of the Consultant. No reduction of strands is permitted at terminations. No wire smaller than 1.5 sq.mm shall be used. Wherever wiring is run through trunkings or raceways, the wires emerging from individual distributions shall be bunched together with cable straps at required regular intervals. Identification ferrules indicating the circuit and DB number shall be used for sub main sub-circuit wiring. The ferrules shall be provided at both end of each sub main and sub-circuit.

Where single phase circuits are supplied from a three phase and a neutral distribution board, no conduit shall contain the wiring fed from more than one phase. In any one room in the premises where all or part of the electrical load consists of lights, fans and/or other single phase current consuming devices, all shall be connected to the same phase of the supply. Circuits fed from distinct sources of supply or from different distribution boards or through switches or MCBs shall

not be bunched in one conduit. In large areas and other situations where the load is divided between two or three phase, no two single phase switches connected to different phase shall be mounted within two meters of each other.

All splicing shall be done by means of terminal blocks or connectors and no twisting connection between conductors shall be allowed.

Industrial sockets shall be of polycarbonate and deeply recessed contact tubes. Visible scraping type earth terminal shall be provided. Socket shall have self adjustable spring loaded protective cap. Socket shall have MCB/ELCB/RCCB as specified in the schedule of work.

Fire Seal System

All the floor/wall opening provided for cable crossing shall be sealed by fire seal system.

The fire proof sealing system shall fully comply with the requirements of relevant IS/BS: 476 Part-B. The fire proof seal system shall have minimum one hour fire resistance rating.

The fire proof seal system shall be physically, chemically, thermally stable and shall be mechanically secured to the masonry concrete members. The system shall be completely gas and smoke tight, antirodent and anti-termite.

The material used in fire proof seal system shall be non-toxic and harmless to the working personnel.

Type of fire proof seal system shall be foaming type or flamemastic type compound or approved equivalent.

After laying and jointing work is completed, high voltage test should be applied to all cables to ensure that they have not been damaged during or after the laying operation and that there is not fault in the jointing.

Cables for use on low and medium voltage system (1.1KV grade cables) should withstand for 15 minutes a pressure of 3000V, DC applied between conductors and also between each conductor and sheaths. In the absence of pressure testing facilities it is sufficient to test for one minute with a 1000V insulation tester In case the test results are unsatisfactory the cost of repairs and replacements and extra work of removal & laying will be made good by the contractor.

Cable shall be installed so that separations shown in the table below are observed.

1.	ELV & LT 230 V/433 V	- ELV & LT cable 230 V/433 V	50 mm
2.	All cables	- All hot pipe work	200 mm

Factory Tests

Each type of cable specified shall be fully type tested according to IEC 502 and the appropriate Indian Standards. The types and sizes of cables required are shown on the Drawings.

Should the Engineer require it, the Contractor shall submit reports issued by a national or international testing authority on type test that have been successfully performed on the cable for his approval.

The type test shall include the following test:

1. Partial discharge test;
2. Bending test, plus partial discharge test;
3. Tan δ measurement as a function of the voltage and capacitance measurement;
4. Tan δ measurement as a function of the temperature;
5. Heating cycle test plus partial discharge test ;
6. Impulse withstand test, followed by a power frequency voltage test;
7. Medium-voltage alternating current test;
8. Type test (non-electrical) as stipulated in IEC 502, Table VI.

Cable routine test shall be conducted at factory in accordance with IEC 502 for the following tests:

Measurement of the electrical resistance of conductors
Partial discharge test,
4-hour HT test

Site Acceptance Test

The Contractor shall supply all necessary testing equipments for site testing. When required, these testing equipments shall be calibrated at the expense of the Contractor at a recognized national laboratory.

The Contractor shall engage an Authorised Medium Voltage Testing Engineer who is recognized by SEB to perform all site tests.

In addition to SEB's requirements and those recommended by the manufacturer, the following tests shall be carried out:

1. Continuity test
2. Earth test
3. Polarity test
4. Insulation resistance test
5. DC high voltage test. The test voltage shall be in accordance with SEB's requirements and Engineer's approval.

3.0 WIRING DEVICES

Work Description

The drawings for the lighting and power points indicate approximate position of all lighting fittings, switches, power outlet points, isolating switch points etc. The actual position of all fittings, switches, the wiring details and cable routes shall be co-ordinated with other trades at site and submitted for the approval of the Engineer-in-charge. All time and cost required for adjusting the layout or complete installation to suit site requirement is included.

To determine the exact positioning of lighting and power points due consideration shall be given, for selection of the most accessible routes for wiring, convenience of switching and operational requirement of the installation.

No extra cost will be paid should the final positions be relocated within the same room.

For the purpose of specification and related drawing, each lighting & power point circuit shall be coded with a prefix to indicate the corresponding distribution board number.

The electrical equipment/system may develop sudden changes due to low frequency or direct electric current components such as fluorescent lamps, contactors, etc. shall be fitted with radio and television interference suppression components suitable to meet the levels specified in BS: 800 "Limits of Radio Interference".

This section included the specification of the following:

1. Distribution boards
2. Miniature circuit breakers
3. Earth leakage circuit breakers
4. 6A Switch Socket Outlet
5. 16A Switch Socket Outlets
6. Shaver Outlets
7. Isolating Switches
8. Conduit Boxes

9. Contactors
10. Dimmers Switch
11. Time Switch
12. Cooler Control Units
13. Water Heater Switches
14. Bell Push Switches

Standards

The complete wiring installation shall be engineered according to manufacturer data and constructed in accordance with the latest revision of the IS and the appropriate BS/IEC

In the adoption of standards and requirements, the Contractor shall take the following precedence:

1. Engineer's decision
2. Local codes of practice
3. Drawings
4. Specification
5. International standards and requirements

Submission

The submission shall include the following as a minimum requirement,

1. Sample submission include all wiring accessories
2. Shop Drawings of the lighting and power positions, circuit numbers, cable routings, switching arrangement, mounting height, etc. The positions and mounting heights shall be coordinated with other services. Fixing details of all wiring accessories shall also be included.
3. Drawings showing the installation details
4. Labeling system.

Lighting Point Installation

The various types of light fittings to be supplied and installed as per approved drawings.

Surface mounted light fitting shall terminate at junction box having entries appropriate to the run of conduit. This shall be complete with porcelain / PVC connector suitable for the size and number of connections and wiring points to be connected with the specified fitting. Wiring to the light fittings within the false ceiling space shall be by means of heat resistant (butyl or silicon rubber insulated to BS 6500) cables i.e. between the junction box and the lamp holder/terminal blocks, in flexible conduits.

At every light fitting an approved type earth terminal shall be provided for connection of the circuit protective conductor of the final circuit.

Ferrous metal work shall be of minimum of 1mm thickness and treated against corrosion by galvanising after welding or lead primer or other approved process. Metal work shall be painted with one priming coat, one under-coat and two final coats with stove-enamelled matt white paint unless otherwise specified.

Cables used for internal wiring of the lighting fittings shall be with appropriate type and size, number with conductor of size not less than 1.5 sq mm single core. The insulation of the cables

shall withstand the maximum temperature throughout the life of the fitting. It will be subject to normal use without deterioration which could affect the safety of the fitting.
Cables within the lighting fittings shall be neatly bundled by nylon self locking cable ties. Wiring shall be properly routed and secured away from control gear etc. wherever possible.
All cable terminations within the light fittings shall be suitably shrouded.
All light fittings shall be supported with appropriate fixing accessories such as clips, supporting brackets, suspension sets, nuts, washers, screws etc. for their proper installation on different types of ceiling panels. Suspension sets shall be of adjustable type suitable to carry the weight of the lighting fittings unless otherwise stated or indicated on drawings. The suspension sets shall be generally of 900mm length. Exact lengths required shall be provided to suit the site requirement.
All lamps in operational condition with proper control gear shall be provided together with the light fittings as required and specified.

Switches

All Lighting switches in BSL-3 Laboratory (within containment barrier) shall be IP-66 or better.
Lighting switches unless otherwise specified, shall be single pole, quick make and break, silent action type with solid silver alloy contacts and totally enclosed for flush or surface mounting as required.
Lighting switches shall be suitable for indoor or outdoor service according to location housed in standardized purpose manufactured galvanized steel boxes completed with conduit knockouts made up into single or multi-gang units employing a grid switch system of fully interchangeable components at standardized fixing centers of matching switches of different types and ratings but of identical dimensions, push buttons, neon indicator lamps, blanking units, grids, steel boxes and plates all capable of integration into standard composite assemblies in any combination as required.
Grids shall be adjustable for variation in depth of plaster and for squaring errors and of the same type for surface or flush mounting.
Switches in mechanical plant rooms and electrical sub-stations and switch rooms shall be of the metal clad type approved by the Engineer-in-charge mounted in flush or surface conduit boxes as specified.
Switches located on brick or concrete walls shall be mounted in horizontal arrangement in plaster depth steel boxes or in galvanized steel boxes using box suspension straps and cover plates. Countersunk screws shall be provided for fixing to the conduit boxes.
Switches for external use shall be of weatherproof construction with IP-65 rating unless otherwise specified.
Samples of all switches, conduit boxes and plaster depth boxes shall be submitted to the Engineer for approval prior to installation.
Switches shall be rated for 6Amps (minimum light switch rating 6Amps), 16Amps or 20Amps (as determined by circuit load). Inductive lighting circuit shall be assessed at twice the steady state connected load current. One or two ways switch as indicated on the drawings be fixed generally at a height of 1200mm from floor level in rooms. The switch shall possibly be located inside the room on the handle side of the door as close as practicable.
Earth continuity terminal shall be provided and connected to the circuit protective conductor at every lighting switch position.
Single pole switches shall be connected to break the phase wire of the supply. The neutral wire shall not be routed through switch boxes.

Switches which are mounted in the same location shall be of multi-gang type, of the maximum number of gangs available.
All switches used shall be of approved or prescribed items as required by local Authorities.
Circuit from different phase and circuit from emergency power should have separate switch plate.

Isolation Switch
Isolating switches shall be of the current ratings and number of poles (generally double pole for single phase and 4-pole three phases) as indicated on the Drawings.
Isolating switches shall be of the totally enclosed pattern, metal-clad or polycarbonate with positive quick-make and quick-break action.
Switches shall be capable of passing and interrupting their full rated current safely and without damage.
Ferrous materials shall be galvanised, switch handles shall be interlocked to prevent opening the cover with the switch "ON".

6AMP Switch Socket Outlets
All 6AMP switches and sockets in BSL-3 Laboratory (within containment barrier) shall be IP-66 or better. The IP rating shall remainintact even in plugged condition. Each outlet shall be provided with compatible plug top.
General Switch socket outlets shall be as per BS: 1363 single pole 6Amp 3round pin shuttered outlets, one or two gang for indoor service except otherwise specified and suitable for surface or flush mounting according to location.
Switches shall be of the quick-make and break type silent action totally enclosed with solid silver alloy contacts. Switched socket outlets for indoor use shall be housed in suitable galvanized steel boxes as per BS: 4662 with conduit knockouts. Types and finishes of socket plates shall match those for the lighting switches.
Generally switch socket outlets shall be positioned 300mm above floor level except in plant rooms, kitchen, etc. where they shall be positioned 1400mm above floor level or 150mm above counters or benches as per requirement.
Switch socket outlet in all mechanical plant rooms, electrical switch rooms shall be of the metal clad type, with recessed or protected switch dolly, mounted in flush or surface conduit boxes as specified.
All switch socket outlets used shall be of an approved quality.

16 AMP Switch Socket Outlets
All 16AMP switches and sockets in BSL-3 Laboratory (within containment barrier) shall be IP-66 or better. The IP rating shall remainintact even in plugged condition. Each outlet shall be provided with compatible plug top.
General 16Amp switch socket outlets shall be 3pin round type to BS: 546 shuttered, of finished similar to 6Amp switch socket outlets and flush mounted in galvanised steel conduit boxes to BS: 4662 requirements.

Weatherproof Isolator
Weatherproof enclosure shall be of the high impact, water resistant to IP-65. The isolator provided shall complete with lockable device. Isolators shall be 2-pole, 4-pole as specified.

Floor Box-Access Outlet.
All plates shall be made from stainless steel or equal approved, heavy duty trap cover. All plates are to be mounted flush with surface and are to be aligned correctly. Access Outlet should carry service plates for providing services i.e. Power, Data & Telecom. The system must comply the

relevant specification & IEC 61084 standards. The system should have Positive Double Earthing connections.

Lighting Dimmers Switch

Lighting dimmer switch shall be solid state, variable load and thyristor controlled type suitable for controlling fluorescent or incandescent lighting circuits operating at 230V ± 6%, 50Hz single phase AC supply.

Dimmer switch shall be manufactured to eliminate TV and radio frequency interference in compliance with IS.

The ratings of the dimmer units shall be suitable for lighting circuit specified on Drawing.

Time Switches

Time switches shall be self-contained unit suitable for mains operation. All units shall have self-starting synchronous motor with single-pole fuse in the motor circuit, 3-way terminal block and thirty-six (36) hours spring reserve complete with an automatic solar dial.

The solar dial shall be capable of switching ON The lighting at sunset and OFF at sunrise throughout the year by control of a secondary calendar dial with month and day settings. The automatic switching time shall be adjustable.

Time switches shall be encased in dust-tight metal casing having hinged front cover with clear Perspex window. The casing shall be effectively earthed.

A manual bypass switch shall be incorporated with the time switch to facilitate maintenance of the latter.

Miniature Circuit Breaker

The MCB shall be suitable for manual closing, opening and automatic tripping under overload and short circuit. The MCB shall also be trip free type.

Single pole / three pole versions shall be furnished as required.

The MCB shall be rated for 10KA fault level.

The MCB shall be suitable for housing in the lighting boards and is suitable for connection at the outgoing side by tinned cable lugs and for bus-bars connection on the incoming side.

The terminal of the MCB and their open and close conditions shall be clearly / indelibly marked.

The MCB shall generally conform to IEC/ IS: 60898

Earth Leakage Circuit Breaker

ELCB shall be 4 pole 415 volts 50Hz, 30-300mA sensitivity. These shall be of approved make. The rating of the ELCB shall be as required. These shall be suitable for manual closing and opening and for automatic tripping under earth fault circuit of 30-300 mA as specified in item of work.

The enclosure of the ELCB shall be moulded from high quality insulating material. The material shall be fire retardant, anti tracking, non-hygroscopic, impact resistant and shall with stand high temperature.

All parts of switching mechanism shall be non-greasing, self lubricating material so as to provide consistent and trouble free operation.

Operation of ELCB shall be independent of mounting position and trip free type.

Lighting/Small Power Distribution Boards

Distribution boards shall be of standard make with MCBs as per approved make given. Distribution boards shall be of steel sheet construction double door all welded enclosure of IP42 protection and powder coated painted.

Ample clearance between the conductors of opposite pole and sheet steel body shall be maintained in order to obviate any chance of short circuit. Removable conduits entry plates shall be provided at top and bottom to facilitate drilling holes at site to suit individual requirements.
Additional / separate adopter box of suitable size shall be provided to accommodate wires, cables and No. of conduits etc. at no extra cost.
The MCB shall be mounted on high grade rigid insulating support and connected by electrolytic copper bus bars.
Each incoming MCB isolator shall be provided with solder-less cable sockets for crimping.
Phase separation barriers made out of arc resistant materials shall be provided between the phases. Bus bars shall be colour coded for phase identification.
Distribution boards shall be recessed in wall or mounted on surface of wall with necessary mounting arrangement.
The mounting height shall not exceed 1200mm from finished floor level. Distribution board shall be provided with proper circuit identification name plate and danger sticker/plate as per requirement.
All the distribution boards shall be provided with engraved name plates with 'lighting', 'power' or 'UPS' with DB Nos., as the case may be.
Each DB shall be provided with circuit list giving details of each circuit. All the outgoing circuit wiring shall be provided with identification ferrules giving the circuit number & phase.
Each distribution board shall have separate neutral and earth connection bar mounted within the DB each having the same number of terminals as the total number of outgoing individual circuits from the distribution board. Conduit & cable armouring shall be bonded together & connected to the distribution board earth bar.
Where oversized cables are specified due to voltage drop problems, it shall be contractors responsibility to ensure that satisfactory terminal arrangements are provided without an extra cost.

Cooler Control Units
Cooler Control Units shall be flush mounted double pole AC switch of rating 30Amps complete with pilot indicating lamps and with self adhesive plastic identification label mounted on a removable chassis contained within steel box finished aluminium stove enamel provided with conduit knockouts and earthing terminals. The cover plates shall be of the same finish as those specified for the lighting switches.
Associated connector units shall be provided adjacent to the cooler units.
Wirings between the cooler control units and associated connector units shall be provided in concealed conduits.

Water Heater Switches
Water heater switches shall be flush mounted having double pole AC switch rated at 20amps fitted with pilot lamp and marked "water heater". The cover plates shall be of the same finish as those specified for the other switches. Associated connector units shall be provided next to the water heater units.

Power Supply for Lighting at Wet Condition
Residual Current Circuit Breakers shall be provided individually for each circuits serving lighting subject to wet condition.

4.0 MEDIUM VOLTAGE PANELS
(Applicable for panels other than Main LT Panel and Panels with Incomer less than 630A)

GENERAL

Medium Voltage power control centers (generally termed as switchboard panels) shall be in sheet steel clad cubicle pattern, free floor standing type, totally enclosed, compartmentalized design having multi-tier arrangement of the incomers and feeders as per details given in the schedule of quantities. The panels shall be of extensible type with provision of bus bar extensions. All panels shall conform to the requirements of the latest addition of IS and shall be suitable for 415 V, 3 phase AC supply or 230 V single phase AC supply as required.

CONSTRUCTION

All switch board panels or power control centers of free standing type shall have a bus bar chamber at the top and the cable compartment at the bottom or as approved by the Developer/Consultants depending upon the specific requirements of the job. The space between the bus chamber and cable compartment shall be suitably compartmentalized to accommodate either air circuit breakers or molded case circuit breaker of various ratings. The cable terminations shall be carried out on the rear side of the panels for which adequate space and clamping arrangements shall be provided. Where panels have to be installed with very little access space at the rear, the cable terminations shall be carried out in suitable cable alleys provided on the front of the panel. All the live parts shall be properly shrouded with Bakelite barriers. All the equipment shall be accessible from the front. However, protection relays, KWH meters, etc. may be mounted on the rear side/front side. Arrangements and marking of bus bars, main connections and wiring shall be in accordance with latest IS code. The structure of the panel shall be robust and provided with adequate bracing's to withstand the operation of the equipment and stresses due to system short circuit. The panels shall be fabricated out of best quality heavy gauge sheet steel. The panel shall be machine pressed with punched openings for meters, indicating lamps etc.The enclosure system shall be Modular in nature with bolted on construction. Enclosure parts/kits shall be interchangeable to reduce downtime during modification or maintenance work. Enclosure system and switchgear components shall be from same manufacturer.

DIMENSIONS

All power control centers shall have dimensions of not more than that given in the approved drawings. Panels arranged side by side shall have the same height and depth. The height of the panel should be limited to 2400 mm. All the operating levers, handles etc. of the highest unit shall not be at a height more than 1700 mm from F.F.L. For all incoming cables a removable gland plate will be provided in the panel and a minimum distance of 300 mm will be provided between the gland plate and the nearest terminal for proper dressing and termination of the cable. All the components of a module will be mounted on a component plate using the machine screws and taped holes (excepting the components mounted on the door). These component plates should be fixed with bolts for easy replacement. Standardization will be adopted while making these plates so that the component plates of the same size modules can be changed from one module to another. In case of panel of lengths more than 4 meters the fabrication of any single section will be limited to a maximum length of 4 meters for the purpose of shipping and shifting at the site. These sections will be assembled at the location of installation with the help of nuts and bolts. While making these sections consideration will be given to the place of sectionalizing and select the location where the minimum electrical connections are transferred from one section to another. All the hardware used in the assembly will be electroplated for protection and neat appearance.

BUS BARS

The bus bars shall be suitable for 4 wire, 415 Volts, 50 Hz, system. The main bus bar shall be made of high conductivity electricity conductor grade electrolytic AL 91E Aluminum and shall be liberally sized. In case of copper bus bar it shall be electrically conductor grade electrolytic copper and at the time of joining of two copper buses tinning will be done on the copper strips ends to a length equal to the lap length of the joint plus one each. The bus bars shall have uniform cross

section throughout. The bus bars shall be capable of carrying the rated current at 415 Volts continuously. The bus bar will run in a separate busbarbus bar chamber using bus insulators made of non-deteriorating, vermin proof, non hygroscopic materials such as epoxy fiber, reinforced polyester or molding compound. The interval between the two insulators will be designed after considering:

a. Strength and safe load rating of the insulator,
b. The vibrating force generated during a fault,
c. A Factor of safety of 1.8
d. A set of insulators at both ends of the bus.

The size of the bus bar calculations must be approved by the Engineer-in-charge. The bus bars shall be designed to withstand a temperature rise of 45o above the ambient. To limit the temperature rise in the bus bar chamber a set of louvers can be provided at strategically places considering the air circulation. The louvers provided will have a brass wire mesh covering from inside with more than 100 openings per sq. inch. The overall temperature of bus bar shall not exceed 85°C in any case. A current density of 1.0 Amps/Sq. mm shall not be exceeded for Aluminum bus bars.

All the bus bars shall be insulated with PVC heat shrinking sleeves suitably throughout (except at joints) the length. The electro galvanized galvanized high tensile steel nuts, bolts, plain or spring washers of suitable size will be used in connecting the various section of the bus bar. A minimum of 1.6 times the width of bus bar will be the lapping length of each joint.

EARTHING

The panels shall be provided with an aluminum or copper earth bus of suitable size running throughout the length of the switchboard. Suitable earthling eyes/bolts shall be provided on the main earthing bus to connect the same to the earth grid at the site. Sufficient number of star washers shall be provided at the joints to achieve earth continuity between the panels and the sheet metal parts.

INTERLOCKING

The panels shall be provided with the following interlocking arrangement.

a. The door of the switch-fuse compartments is so interlocked with the switch drive or handle that the door can be opened only if the switch is in `OFF' position. De-interlocking arrangement shall also be provided for occasional inspection.

b. It shall not be possible for the breaker to be withdrawn when in `ON' position.

c. It shall not be possible for the breakers to be switched on unless it is either in fully inserted positions or for testing purposes in fully isolated position.

d. The breaker shall be capable of being raked in to `testing' `isolated' and `maintenance' positions and kept locked in any of these position.

e. A safety latch to ensure that the movement of the breaker as it is withdrawn, is checked before it is completely out of the cubicle shall be provided.

PROTECTION & INSTRUMENTATION

Protection and instrumentation shall be as per standard specifications.

All ACBs, MCCBs of Main LT Panel and Incomer MCCBs shall have inbuilt Earth Fault Protection.

CONTROL WIRING

The control wiring of all the panels will be done with PVC single core flexible copper wires of cross section 1.5 sq. mm and 2.5 sq. mm. All the wiring involving current transformers or circuits with currents of more than 5 Amps will be wired with 2.5 sq. mm cross section wire and the others with 1.5 sq. mm. Similarly all the interconnecting between the incoming bus and the outgoing of 100 Amps and above rating shall be done by insulated copper strips of suitable sizes and equipment below 100 Amps rating shall be wired with insulated copper conductors. All of the control wiring will be done by properly dressing all the wires in a laminar manner either in a PVC duct of liberal size or bunched together by PVC strapping tapes at a distance not exceeding 150 mm. Each wire will terminate with a copper ferule crimped to the wire. The PVC ferules will be used to identify each wire of the circuit and the same number will be marked on the drawing for the corresponding wire. Only one outgoing wire will be connected to one connector. When the control wiring is crossing from fixed parts to moving parts such as door etc. the wire will be run in PVC sleeve of suitable size and the same will be mechanically clamped at both the ends i.e. one end of the fixed part and the other on the moving part. Under no circumstances the wiring should be under any kind of stress for which sufficient length of control wiring in the PVC sleeve should be provided. All the potential circuits shall be protected by fuses mounted near the tap off point from the main connections.

SURFACE TREATMENT

The each part of the fabricated panel will be subjected to seven tank treatment and all sheet metal accessories and components of power control centers and switchboard panels shall be thoroughly cleaned, degreased, de-rusted and hot dip phosphatized before red oxide primer is applied. The panel shall be stove enameledgray shade finish and the Interior surfaces of the panel shall be painted to an off-white shade.

ENCLOSURE

The panel enclosure shall be totally dust and vermin proof and shall be suitable for indoor installation. All the cubical will be adopted with front located, outward openings, lockable doors having hidden hinges and a bolted back cover both using no deteriorating neoprene rubber gasket. Enclosure design shall be in accordance with degree of protection IP 54 as per latest IS code. All the nut bolts handles, meters, knobs etc. appearing from outside of the panel should be in symmetry so as to give a neat appearance.

NAME PLATE

The panel as well as the feeder compartment doors shall be provided with name plate giving the switchboard/feeder descriptions as indicated on the drawings. The above shall be mounted in metal holder with a clear plastic sheet on inside surface of the front door.

TESTING

The power control centers shall be tested at factory after assembling of all components and completion of all interconnections and wiring. Tests shall be conducted in accordance with the requirements of BS:3659.

Insulation Test

a. Insulation of the main circuit, i.e. the insulation resistance of each pole to the earth and that between the poles shall be measured.
b. Insulation resistance to earth of all secondary wiring should be tested with 1000 Volt magger. Insulation test shall be carried out both before and after high Voltage test. High Voltage Test A High Voltage test with 2.5 KV for one minute shall be applied between the poles and earth. Test shall be carried out on each pole in turn with the remaining poles earthed, all units raked in position and the breakers closed. Original test certificate shall be submitted along with panel.

STORING, ERECTION AND COMMISSIONING

The panels shall be stored in a well ventilated, dry place, with a suitable polythene covers shall be provided for necessary protection against moisture.

Erection

Switch boards shall be installed on suitable foundation. Foundation shall be as per the dimensions supplied by the panel manufacturer. The foundation shall be flat and leveled. Suitable grouting holes shall be provided in the foundation. Suitable MS base channel shall be embedded in foundation on which the panel can be directly installed. The switch boards shall be properly aligned and bolted to the foundation by at least four bolts. Cables shall be terminated on the bottom plate or top plate as the case may be, by using high quality brass compression glands. The individual cables shall then be led through the panel to the required feeder compartments for necessary terminations. The cables shall be clamped to the supporting arrangement. The switchboard earth bus shall be connected to the local earth grid.

Pre-commission Tests

Panels shall be commissioned only after the successful completion of the following tests.
The tests shall be carried in the presence of Engineer-in-charge or their representatives.
All main and auxiliary bus bar connections shall be checked and tightened.
All wiring termination and bus bar joints shall be checked and tightened.
Wiring shall be checked to ensure that it is according to the drawing.
All wiring shall be tested for insulation resistance by a 1000 Volts magger.
Phase rotation tests shall be conducted
Suitable injection tests shall be applied to all the measuring instruments to establish the correctness and accuracy of calibration and working order.
All relays and protective devices shall be tested for correctness of settings and operation by introducing a current generator and an Ammeter in the circuit.

METERING, INSTRUMENTATION AND PROTECTION.

Ratings, type and quantity of meters, instruments and protective devices shall be as per Approved Drawings by Engineer-in-charge.

Current Transformers

CTs shall confirm to latest IS codes in all respects. All CTs used for medium Voltage application shall be rated for 1 kV. CTs shall have rated primary current, rated burden and class of accuracy as specified in schedule of quantities/drawings. Rated secondary current shall be 5A unless otherwise stated. Minimum acceptable class for measurement shall be 0.5 to 1 and for protection class 10. CTs shall be capable of withstanding magnetic and thermal stresses due to short circuit faults. Terminals of CTs shall be paired permanently for easy identification of poles. CTs shall be provided with earthing terminals for earthing chassis, frame work and fixed part of metal casing (if any). Each CT shall be provided with rating plate indicating:

- Name and make
- Serial number
- Transformation ratio
- Rated burden
- Rated Voltage
- Accuracy class

CTs shall be mounded such that they are easily accessible for inspection, maintenance and replacement. Wiring for CT shall be with copper conductor PVC insulated wires with proper termination works and wiring shall be bunched with cable straps and fixed to the panel structure in a neat manner.

Potential Transformer

PTs shall confirm to latest amendment up to to date IS Codes.

Measuring Instruments

Direct reading electrical instruments shall conform to latest IS codes in all respects. Accuracy of direct reading shall be 1.0 of Voltmeter and 1.5 for Ammeters. Other instruments shall have accuracy of 1.5. Meters shall be suitable for continuous operation between -100C and +5000C. Meters shall be flush mounting and shall be enclosed in dust tight housing. The housing shall be of steel or phenolic mould. Design and manufacture of meters shall ensure prevention of fogging of instrument glass. Pointer shall be black in colour and shall have Zero position adjustment device operable from outside. Direction of deflection shall be from left to right. Selector switches shall be provided for Ammeters and Volt meters used in three phase system.

5.0 MCCB, MCB & RCCB'S FOR MAIN LT PANEL

GENERAL:

MCCBs shall comply with standards IS/IEC 60947-1 & 2. The breaking capacity performance certificates shall be available for category A to the above mentioned standards.

MCCB shall have a rated operational voltage (Ue) of 415V, insulation voltage (Ui) of 750 V (AC 50/60 Hz) & impulse voltage (Uimp) of not less than 8kV.

MCCBs shall be current limiting type with trip time of less than 10 m sec under short circuit conditions. The MCCBs should be either 3 or 4 poles fixed type. The design is required to minimize the effects of short circuit currents i.e. limit the let through energy and improve the life of cables.

MCCB shall not have any line load bias

PERFORMANCE:

The MCCBs shall have a rated service breaking capacity (Ics) equal to the ultimate breaking capacity (Icu) at 415V and as per system fault levels (refer SLD).

SAFETY:

For maximum safety, the power contacts shall be insulated in an enclosure made of a thermosetting material from other functions such as the operating mechanism, the case, the trip unit and auxiliaries (ON/OFF/Trip Contact, Shunt, Under Voltage etc.). All poles shall operate simultaneously for circuit breaker opening, closing and tripping.

MCCBs shall be actuated by a toggle or rotary-handle that clearly indicates the three distinctive positions: ON, OFF and TRIPPED. MCCB shall clearly indicate the suitability for isolation in the name plate identified by the symbol  . MCCBs shall be equipped with a "push to trip" button in front to test operation and simultaneous opening of all poles together.

The electrical life of MCCBs shall be 8,000 operations up to 250A & 4000 operations up to 630A

All MCCBs termination should be done using circular lugs being bolted to MCCB, to enhance safety and reliability of the terminations. In case spreaders/rear connectors are used in between MCCB and bus bar/lugs then the spreaders shall be cross bolted with the MCCB connectors.

AUXILIARIES AND ACCESSORIES:
Following separate Field installable auxiliary contacts for signalizing ON/OFF indication shall be provided with all MCCBs
Rotary handle shall ensure IP40 for direct type and IP 55 for extended Rotary handle.

PROTECTIONS REQUIREMENTS:
All MCCBs upto 250A shall be thermal magnetic type with adjustable overload settings from 0.8 to 1 times In and adjustable magnetic settings.
All MCCBs above 250A upto 630A shall be self-powered microprocessor based type having adjustable O/L, S/C & inbuilt Earth Fault protections
In case of 4 pole microprocessor based MCCBs neutral shall be protected & adjustable as a Neutral unprotected / Neutral protected at 0.5 In/ Neutral protected at In.
In case of 3 Phase 4 Wire Systems, if 3 Pole MCCBs are specified then Vendor should provide Neutral CT from MCCB Manufacturer.
For Motor application, motor duty type MCCBs shall be selected with reference to Type 2 coordination chart provided by the manufacturer**.**

METERING:
Microprocessor based MCCBs in Main LT Panels shall be capable of measuring the following data

a. ON, OFF and Trip status, current, voltage, energy, power, power factor and THD for current and voltage
b. Last 10 trip histories with date and time stamping
c. Additional protections for Current & Voltage unbalance, Under & Over Voltage, Under & Over Frequency, Maximum demand etc
d. Panel door mounted display for display of Current, Voltage, Energy & Power parameters
e. Communication capable release on MODBUS RTU for BMS/SCADA for Status communication & parameterization

All MCCBs shall have Phase Barriers & Extended Rotary Operating Handles. The Rotary operating mechanism shall be of robust design and should be with door interlock & padlock facility.

All MCCBs above 63A shall be provided with Silver Plated Copper Spreader Links for enhancing termination capacity

MINIATURE CIRCUIT BREAKERS & RESIDUAL CONTROL DEVICES
Miniature circuit breakers shall be of approved design and make and must be tested and validated as per IS/IEC 60898 and IEC 60947-2 standards.
MCBs shall be suitable for operation at 240V/415V, 50Hz supply. The MCB ratings shall be available from 1--125A in 1P/2P/3P/4P versions. The rated short circuit capacity shall be 10KA as per IS/IEC 60898 and electrical life shall be 10,000 operations. MCBs shall be offered with B, C or D tripping characteristics as per the requirements. The MCBs shall be suitable for mounting on a 35mm DIN rail.
MCBs shall carry ISI and CE marking. The MCB manufacturer (through the bidder) has to submit the valid BIS license certificate at the time of offer submission.
MCBs shall ensure complete electrical Isolation of downstream circuit or equipment, when the MCB is switched OFF (to be marked on the MCB in symbolic form)
IP 20 Degree of Protection shall be ensured to prevent electrical shocks by accidental touch to any live parts, by providing finger touch proof terminals.
Energy Limitation Class-3 shall be to ensure minimum let through energy in the event of a fault, for safety & longevity of downstream circuit equipment. (to be mentioned on the as per standards)

MCBs shall be line-load reversible with no derating @ 35 deg C.
MCBs shall have bi-connect facility to terminate fork type busbar and wires, simultaneously. Terminal capacity shall be minimum 25 sq.mm. for ratings up to 25A, and 35 sq.mm. for ratings 32A & above to ensure perfect termination of wires and cables. Terminals of MCBs shall have captive screws.
Basic technical parameters, rating, operating voltage, energy limiting class 3 etc. shall be printed on front face of MCB for ease of identification. MCB should have clear indication on front facia for tripping on Short circuit faults for differentiation between O/L & S/C faults
The devices must be capable of heavy-duty operation and to that end, the manufacturer shall guarantee the following performance levels, defined by IEC / EN 60947-2 standards:
- suitability for isolation (section 7.2.7)
- rated insulation voltage (section 4.3.1.2): 500 V
- pollution degree (Part 1, section 6.1.3.2): 3
- rated impulse-withstand voltage (section 4.3.1.3): 6 kV
- Discrimination for power continuity
- Validated Cascading tables as per standard IEC 60947-2

Operating knob shall have provision to lock in ON / OFF condition without affecting any automatic tripping
Circuit-breakers shall be capable of operation under ambient temperature up to 35 °C, without derating of their overload tripping threshold with respect to their rated operating current. The same must be tested and validated as per IEC 60947-2 standard.
MCBs shall be suitable for field-fittable Protection auxiliaries (viz. Over-voltage release, Under-voltage release, Shunt trip) and Indication Auxiliaries (like Auxiliary Contact, Trip alarm contact).
For critical application feeders wherever specified for remote monitoring of circuit breakers status is required, MCB shall be communication ready to indicate the status of the device (On/Off/Trip), Number of On/Off cycles and Number of Tripping over universally open Modbus protocol so as to have seamless connectivity with any Energy and Building Management System.

RESIDUAL CURRENT CIRCUIT BREAKERS (RCCBS):
RCCBs must conform to IS12640 -1 and IEC/EN 61008 standards.
RCCBs shall be suitable for operation at 240V/415V, 50Hz supply. The RCCB ratings shall be available from 25A-125A in SPN and TPN versions with the sensitivity of 30mA (for personal protection) and 100/300mA (for Fire protection), as per the BOQ requirements. Rated conditional short circuit shall be 10KA RMS
RCCBs shall carry ISI marking. The RCCB manufacturer (through the bidder) has to submit the valid BIS license certificate at the time of offer submission.
RCCBs shall have clear indication of 'Tripping on earth leakage fault' on front facia. RCCBs shall have Electrical life of 10,000 operations for all ratings
RCCBs shall have bi-connect facility to terminate fork type busbar and wires, simultaneously. Terminal capacity shall be minimum 25 sq.mm. for ratings up to 32A, and 35 sq.mm. for ratings above 32A, to ensure perfect termination of wires and cables. Terminals of RCCBs shall have captive screws.

6.0 EARTHING SYSTEM

Work Description
This section covers design, and setting of the complete earthing network for individual earthing systems, circuit protective conductors and bonding conductors and, supply, installation, testing, commissioning of earthing system.
A complete earthing network comprising cables, copper tapes, electrodes and earth bonding of all relevant necessary non-current carrying metal parts of equipments/ apparatus shall be connected as required.

The system shall have a common earthing system as described in the specification and as shown on the drawings. Individual earthing systems as per drawing shall be provided for following:

1. HT Electrical Earthing
2. LT Electrical Earthing
3. DG Generator Earthing
4. ELV Earthing
5. Data Communication Earthing

Main HT / LT / Generator Electrical Earthing shall have two earth connections to the earthing system.

Sufficient numbers of electrodes interconnected by Cooper (as per requirement) to form earthing mat so that the overall earth resistance is less than 1 ohm for each individual earthing mat.

The number of earth electrodes of the earthing mat is indicated on the drawings as minimum. The Contractor shall test the resistivity of soil at site and determine the exact number of earth electrodes to achieve the required earth resistance value with approval of Engineer-in-charge. Earth plate, earth mat detail to achieve the earth resistance value shall be included in the Contract for complete earthing installation.

The Contractor shall have approval of materials from engineer-in-charge before use on work. Execution of earthing shall be carried out only in the presence of the Engineer or the representative.

Standards

Complete earthing system shall be designed and executed in accordance with the latest revision of the following standards and the appropriate BS/IEC:

1. IS: 3043 : Earthing
2. BS6651 : Lightning Protection System
3. IEC 61024-1-2 : Lightning Protection System

The detail of the Earthing System shall also conform to the requirements of all relevant local codes as applicable together with the additional requirements referred to in the Specification and Drawings, whichever is the more stringent and acceptable to the Engineer-in charge.

Submission

As minimum requirement the submission for the approval of Engineer-in-charge shall include the following:

1. Shop Drawings and Sample Submission
2. Testing procedures and report format for testing of the earth electrodes and/or earth strips
3. Proposed details of earthing system including quantity and layout of the earth electrodes and/or earth strips according to the calculation result.

PRODUCT

General

The resistance between earthing system and the general mass of earth shall not be greater than 1 ohm.

The earth loop resistance to any point in the electrical system shall not be in excess of 0.5 ohms in order to ensure satisfactory operation of protective devices.

The resistance to earth shall be measured at the following:-

1. At each electrical system ground or system neutral ground.
2. At one point each grounding system used to ground electrical equipment enclosures.
3. At one point each grounding system used to ground wiring system enclosures such as metal conduits and cable sheaths or armoured.

All earthing conductors shall be of high conductivity copper/ G.I. and able to protect against mechanical damage as per requirement. The cross-sectional area of earth conductor shall not be smaller than half that of the largest current carrying conductor. However, the contractor shall use the sizes specified in the bill of quantities of the Tender. Common earth mats of resistivity of less than one (1) ohm shall be constructed below the lowest floor structure prior to any ground work construction. The earth mats shall comprise the complete earth electrodes, earth strips/grids, earth inspection chambers, earth leads, main earth terminals, earth test link boxes at ground level, etc. Each individual earthing system shall have earth leads connecting its main earth terminal directly to an earth electrode underground as specified.

All earthing products/accessories shall be in accordance to IS standards.

The mating surface of all tapes at joints etc shall be cleaned before clamping and riveted with proper connector or exothermic welded. All connections to electrical apparatus shall be made by bolted connection in a visible and accessible position

Pipe Earth Electrode

G.I. pipe shall be of medium class 100mm dia and 3m in length.

G.I. Pipe electrode shall be cut tapered at bottom and provided with holes of 12mm dia drilled not less than 7.5cm from each other up to 2m of length from bottom.

The electrode shall be buried in the ground vertically with its top being 20cm minimum below ground level.

Clamping of the earth leads to the earth rod shall be made by earth clamp. The clamps shall be capable of providing high pressure contact between the earth rod and the earth leads to achieve low contact resistance.

When two or more electrodes are driven to form a group, the heads of the electrodes in the group shall be bonded to each other by means of a 25 mm x 3mm GI / Copper strip, laid at a depth of at least 600 mm in soil.

Recommended water seal insert sleeve approved by Engineer-in-charge shall be provided with all earth electrode penetrations through basement water proofing membranes and the installation shall be done under strict supervision.

Plate Earth Electrode

The plate earth electrode shall consist of copper plate or G.I. plate as per item of work. The plate electrode shall be buried in ground with its faces vertical and top not less than 4.5m below Ground level. The plate shall be filled with charcoal dust and common salt filling, extending 15cm around it's on all sides.

A watering pipe of 50mm dia of medium class G.I pipe shall be provided.

The top of the pipe shall be provided with a funnel and a G.I. mesh screen for watering the earth. In the case of pipe electrode a removable plug shall be provided.

The earthing lead from electrode onwards shall be suitably protected from mechanical injury by suitable dia medium class G.I. pipe in case of wire and size according to strip size.

The overlapping of strips at joints shall done in approved manner

a. GI strips shall be riveted with rivets/ bolted and welded.
b. Copper strips shall be riveted with rivets/ bolted brass nuts, bolts and washers and brazed.

The protection pipe within ground shall be buried at least 30 cm deep (to be increased to 60cm in case of road crossing and pavements).

The portion within the building shall be recessed in walls and floors to adequate depth.

In the case of plate earth electrode the earthing lead shall be securely bolted to the plate with two bolts, nuts, check nuts and washers.

In case of pipe electrode it shall be connected by means of a through bolt, nuts and washers and cable socket.
Main earthing conductor is taken from the earth electrode with which the connection is to be made. No earth pit shall be fixed within 1.5 M of a wall of foundation. The location of the earth electrode will be such where the soil has reasonable chance of remaining moist. Effort shall be made to locate them in grass lawns or near flower beds or water taps.

Earth Inspection Chamber
Earth electrode shall be fitted with a heavy-duty pre cast concrete inspection chamber / pit complete with heavy-duty cover as specified on drawings.
For earth electrodes located outside or on the apron of the building, earth inspection chambers shall extend to a depth of not less than 300 mm below finished ground level and kept free of soil. For earth electrodes located inside building, earth electrodes shall be buried not less than 100 mm below the floor slab structure. Each earth electrode shall be clearly marked **'Safety Electrical Earth Connection – Do Not Remove'**.
The chamber and cover shall be heavy duty detail to consider the traffic load at the location of installation. The cover shall be recessed cover to receive the Architectural floor finish at the location of installation.

Earth Strip
Earth strips/grids shall be Copper strips of minimum 25 mm x 3 mm as required and as approved by Engineer-in-charge.
Earth strips shall be riveted or joint with proper connector to earth electrodes underground below the floor slab structure, and shall be buried not less than 300 mm below the floor slab structure.
In order to minimize the mutual inductance between strips, earth strips shall be positioned at a distance not less than 6m apart unless otherwise specified.

EARTH BONDING

Circuit Protective Conductor
Circuit protective conductor (CPC) is a system of conductors joining together all exposed conductive parts and connecting them to the main earth terminal.
The purpose of circuit protective conductor is to provide a path for earth fault circuit so that the protective device will operate to remove dangerous potential differences during a fault condition.
The circuit protective conductors shall take the form of separate cable with a sheath in green/yellow color or copper tape of minimum size 25mm x 3mm.
All exposed non-current carrying metal parts of light fittings, switchgears, motors, enclosures, etc. shall be effectively earthed by circuit protective conductors for earth continuity protection.
For equipment where an earth terminal is provided, the earth continuity wire shall be firmly clamped. Where no earth terminal is provided, the exposed metal part shall be cleaned of paint and surface rust before welding the earth continuity lead.
The minimum size of the principal protective conductors shall be in accordance with to the current edition of IS: 3043/ BS7671 and BS7430.
The external earth terminal on the outside of the end panel of any switchboard shall be connected to the main earth bar provided in two independent points.
Circuit protective conductors shall be provided in electrical and mechanical rooms and along the routes for the bonding of all exposed conductive parts and extraneous conductive parts. A suitably sized earth terminal shall be provided at each zone of the building for this purpose.
All exposed conductive parts shall be effectively connected in an approved manner to the principal protective conductors. The circuit protective conductors shall be single core copper cables or high conductivity annealed copper tapes specified. Unless otherwise specified, the minimum cross-

sectional area of the circuit protective conductors shall be selected in accordance with IS: 3043/ BS7671.

7.0 FINAL DISTRIBUTION BOARDS & DEVICES:

STANDARDS AND CODES

The latest and amended upto date Indian Standard Specifications and Codes of Practice will apply to the equipment and the work covered by the scope of this contract. In addition the relevant clauses of the Indian Electricity Act 1910 and Indian Electricity Rules 1956 as amended upto date shall also apply. Wherever appropriate Indian Standards are not available, relevant British and/or IEC Standards shall be applicable.

MINIATURE CIRCUIT BREAKERS & RESIDUAL CONTROL DEVICES

Miniature circuit breakers shall be of approved design and make and must be tested and validated as per IS/IEC 60898 and IEC 60947-2 standards.

MCBs shall be suitable for operation at 240V/415V, 50Hz supply. The MCB ratings shall be available from 1--125A in 1P/2P/3P/4P versions. The rated short circuit capacity shall be 10KA as per IS/IEC 60898 and electrical life shall be 10,000 operations. MCBs shall be offered with B, C or D tripping characteristics as per the BOQ requirements. The MCBs shall be suitable for mounting on a 35mm DIN rail.

MCBs shall carry ISI and CE marking. The MCB manufacturer (through the bidder) has to submit the valid BIS license certificate at the time of offer submission.

MCBs shall ensure complete electrical Isolation of downstream circuit or equipment, when the MCB is switched OFF (to be marked on the MCB in symbolic form)

IP 20 Degree of Protection shall be ensured to prevent electrical shocks by accidental touch to any live parts, by providing finger touch proof terminals.

Energy Limitation Class-3 shall be to ensure minimum let through energy in the event of a fault, for safety & longevity of downstream circuit equipment. (to be mentioned on the as per standards)

MCBs shall be line-load reversible with no derating @ 35 deg C.

MCBs shall have bi-connect facility to terminate fork type busbar and wires, simultaneously. Terminal capacity shall be minimum 25 sq.mm. for ratings up to 25A, and 35 sq.mm. for ratings 32A & above to ensure perfect termination of wires and cables. Terminals of MCBs shall have captive screws.

Basic technical parameters, rating, operating voltage, energy limiting class 3 etc. shall be printed on front face of MCB for ease of identification. MCB should have clear indication on front facia for tripping on Short circuit faults for differentiation between O/L & S/C faults

The devices must be capable of heavy-duty operation and to that end, the manufacturer shall guarantee the following performance levels, defined by IEC / EN 60947-2 standards:

- suitability for isolation (section 7.2.7)
- rated insulation voltage (section 4.3.1.2): 500 V
- pollution degree (Part 1, section 6.1.3.2): 3
- rated impulse-withstand voltage (section 4.3.1.3): 6 kV
- Discrimination for power continuity
- Validated Cascading tables as per standard IEC 60947-2

Operating knob shall have provision to lock in ON / OFF condition without affecting any automatic tripping

Circuit-breakers shall be capable of operation under ambient temperature up to 35 °C, without derating of their overload tripping threshold with respect to their rated operating current. The same must be tested and validated as per IEC 60947-2 standard.

MCBs shall be suitable for field-fittable Protection auxiliaries (viz. Over-voltage release, Under-voltage release, Shunt trip) and Indication Auxiliaries (like Auxiliary Contact, Trip alarm contact).

For critical application feeders wherever specified in BOQ for remote monitoring of circuit breakers status is required, MCB shall be communication ready to indicate the status of the device (On/Off/Trip), Number of On/Off cycles and Number of Tripping over universally open Modbus protocol so as to have seamless connectivity with any Energy and Building Management System.

RCCB WITH OVER CURRENT PROTECTION (RCBOS): 2 MODULE VERSION

RCBOs must confirm to IEC/EN 61009 standards.

RCBOs shall be suitable for operation at 240V/415V, 50Hz supply. The RCBO ratings shall be available from 6A-40A in SPN version with the sensitivity of 30mA (for personal protection) and 300mA (for Fire protection), as per the BOQ requirements. Rated short circuit breaking capacity shall be 10KA RMS

RCBO shall have clear separate indication of tripping on Short circuit and earth leakage faults on front facia. RCBO shall have Electrical life of 10,000 operations for all ratings.

DB (DISTRIBUTION BOARD)

Distribution Boards shall be tested as per IEC61439-III standards and have following features:

Recess/ Surface type with integral loose wire box.

Phase/ neutral/ earth terminal blocks for termination of incoming & outgoing wires.

Din Channel for mounting MCBs.

Arrangement for mounting incomer MCB/ RCCB/ RCBO/ MCCB as required.

Copper Bus bar

Earthing bolts- 2 nos.

Wiring from MCBs to phase terminal block.

Terminal blocks should be suitable for termination of conductor/ cable of required size but minimum rated cross section of the terminal blocks should be 6 sq. mm.

Terminal block shall be made of flame retardant polymide material.

Colour terminal blocks and FRLS wires for easy identification of RYB Phases, Neutral and Earth.

Prewired DB shall be provided with a detachable PAN assembly for safe removal of MCBs, RCCBs.

The prewired DB shall have have cement spill protector /masking sheet for protection from cement, plaster, paints etc. during the construction period.

Detachable plate with Knock out holes shall be provided at the top/ bottom of board. Complete board shall be factory fabricated and pre-wired in factory ready for installation at site. The box and cover shall be fabricated from 1.6mm sheet steel, properly pre-treated with 7 tank process and duly powder coated, phosphatized with powder coated finish.

DB shall have neutral & earth terminal block on the side, not on top or bottom to provide better wiring space and hear dissipation inside the DB.

DBs shall be provided with rotary knob and shall have flexibility to change to Key lock on field.

The Ingress Protection for entire range of DBs must be certified by any neutral testing authority (viz. ERDA / CPRI/ any govt certified lab) as per standard IS/IEC 60529 for the degree of;

IP43 for DBs for indoor application and IP 54 for outdoor application

The Impact Protection for entire range of DBs must be certified by any neutral testing authority (viz. ERDA, CPRI, any govt certified lab) as per standard IEC 62262 for the degree of : IK09 for DBs with Double Door

Environmental regulations for Green Buildings : DB shall comply with RoHS and REACH standard and shall have high Strength-to-Weight ratio to avoid burden on building structure.

Where specified it shall be of double door construction provided with hinged cover in the front.

Horizontal TPN DBs shall have Separate Insulated Neutral bar for each phase to achieve per phase Isolation (PPI)

8.0 LIGHT FIXTURES AND FITTINGS

The rooms shall provide with 400-450 lighting Lux level. The Light Fixtures shall be LED type constructed in CRCA Powder coated housing, powder coated bottom frame, LED panel with suitable driver. The construction shall be in slim panel.

a. Rating - 36-42 W and 18-20 W
b. Light Fixtures in BSL-3 & BSL-2 Lab shall be LED IP 65 or better rated, surface mounted type
c. Light Fixtures in Animal Facility shall be LED IP 65 or better rated, surface mounted type
d. Light Fixture in other areas shall be LED Slim Panel, recessed mounted type
e. Performance :

- Cloour temperature (K) - More than 5500
- LED Life with L70 criteria - More than 48000 Hrs
- Input voltage range - 150 – 270 V
- Electrical insulation - Class I

Light fixture installation and wire/cable penetrations shall be seales after installation, to prevent ingress of air.

9.0 ADDRESSABLE FIRE DETECTION AND ALARM SYSTEM

GENERAL

The Contractor shall supply and install the Addressable Fire Detection & Alarm System for the complete facility as per requiement and specified herein specified conforming to NBC. The system shall include Addressable Main Fire Alarm Control Panel, battery charger, batteries, addressable heat detectors, addressable smoke detectors, manual fire alarm station, fire alarm bells/hooters, response indicators, conduiting, wiring and all necessary

accessories required to complete fire alarm system installation as per IS: 2189-2008. Equipment like control panel, smoke detector, heat detectors etc shall be EN-54/ UL approved.

FEATURES

The system shall be general alarm electrically supervised type activation of manual fire alarm station or any of the automatic alarm initiating devices shall sound the general alarm bells on all floors and shall give indication on the control panel. The signal shall be continuous unit the station from which it is originated is restored to normal and a reset button on the control unit is operated.

The system shall be electrically supervised against open and ground on both the stations and signal device wiring. Open and ground in the system shall cause a trouble bell to ring at the fire alarm control panel and a trouble lamp to light. It shall be possible to silence the bell but the lamp shall remain lit until the fault is rectified. Incase of power failure the system shall automatically changeover to the battery standby.

CONDUITING & WIRING

Conduiting & Wiring for FDA system shall be carried out in PVC Conduit with copper conductor PVC insulated wires.

CONTROL PANEL

The fire control panel shall be addressable type. The Main Fire Control Panel shall be constructed to sheet steel of red colour, and provided with windows for the alarm and trouble lights. All components shall be of the plug in type, for simple replacement and extension in the future. Control panel shall be wall mounting type conforming to IS 513-1986.

Each loop shall be able to support at least 128 any device addressable analog/digital (as the case may be) sensors and control module etc. The control panel shall have alphanumeric display. The Main Fire control panel shall be provided with all necessary relays, resistors, fuses, transformers, rectifiers and all other components to assure full and proper functioning of the system. All relays shall conform to the relevant IS Standards. Control panel shall include power include power on lamps, system trouble lamps, audible trouble signal, trouble silence switch with ring back, alarm silence push button with repeat alarm capability, low battery indicator with reset, ground detection indicator, alarm reset, milli ammeter, supervised alarm lamps, zone "Open" test pushbutton, zone alarm test push button, end of line resistors etc.

Each zone shall be equipped with an auxiliary contact for control of a remote annunciation.

Main control panel shall include a power supply model to provide a filtered and regulated source of power to provide additional power wherever supplementary power is required within the system. It shall include an output fuse, key reset switch, provision for automatic transfer to standby power upon primary power failure.

Main control panel shall in addition have audible signal and lamp to indicate as failure of the charge of battery.

Two stages general Alarm shall be provided in which a continuous evacuation alarm is immediately given in zone of fire and its adjoining zones. In other zone intermittent alarm signal shall be provided as per IS 2189-1988.

Repeater Panel shall be of same specification as main control panel and shall have fire/fault indication with audio device.

CHARGER AND BATTERY

Unit shall comprise a ventilated cabinet supplied complete with charger, meters, high rate charge switch and lock and key in a sheet metal enclosure.

ELECTRONIC HOOTERS

Hooter shall be electronic solid-state speaker type having tone for fire, which shall be wailing. Hooter should be loop powered having an output of approximately 6 watt. The audible range shall be around 100m under normal condition. Cable for this in our system shall be 2 cores. The switching shall be provided on the control panel. The outer enclosure of the speaker shall be of MS sheet and shall be suitably oven baked and painted. The speaker shall be 4" heavy magnet type. All hooters shall be on one or more circuits.

MANUAL ALARM CALL POINT FOR SURROUNDINGS (ADDRESSABLE)

The manual call point shall be electrically compatible with the standard range of automatic detectors so that it can be connected directly into a supervised two-wire zone of the manufacturer's standard range of control units. The manual call point shall be of pleasant, streamlined and flat appearance permitting its use as flush and surface mounted unit. The manual call point shall consist of base plate, insert and cover. The push button shall have minimum one normally closed plus one normally open contacts. The push button shall not be shrouded and the same shall be projected out from the surface of the MS Box. The whole assembly of push button shall be enclosed in the 16 SWG MS Box except from the front side. The front side shall be sealed with breakable glass covering neoprene or equivalent gasket. The glass cover shall be fixed in such a way that the actuating push button is kept depressed (with NC contact open) so long as the glass cover is in contact. In case of fire, when the glass cover is broken to give the fire warning the push button shall be released due the spring action hence giving remote fire alarm through the NC contact. The breaking of the glass must release an alarm. All inscriptions, texts and marks must be on the manual call point front plate, not on the glass, so that the glass can easily be replaced anywhere. The alarm contacts shall be of self-cleaning design to prevent failure after a prolonged period of inactivity in unclean environments.

It shall be possible to test the call point without destroying the seal or removing the cover. The manual call point shall be equipped with a self-holding device to maintain the alarm condition until reset by an authorized person. The complete unit and the push button shall be painted signal Red. The internal surface of the MS enclosure of the box shall painted white colour. The external painting shall be of synthetic enameled paint. Aluminium hammer shall be suspended on a hook fixed to the external MS enclosure by means of a non-corrodible easy breaking of the glass cover.

Manual alarm call point located on the outer walls of the building and/or exposed to weather conditions shall be weather proof type and satisfying the requirement of APB.

The manual call point shall be capable of being remotely tested from control panel.

OPTICAL (PHOTOELECTRIC) TYPE SMOKE DETECTORS (ADDRESSABLE TYPE)

The optical type smoke detectors shall be based on light attenuation by smoke/ or light scattering by smoke particles. Smoke detectors shall have an inherently stable sensor with built-in automatic compensation for changes in ambient conditions. All electronic circuits must be solid-state devices and virtually hermetically sealed to prevent their operation from being impaired by dust, dirt or humidity. All circuitry must be protected against usual electrical transients and electromagnetic interference. Reversed polarity or faulty zone wiring shall not damage the detector. The detector shall have no moving parts or components subject to wear. The response sensitivity of each detector shall be factory set. A built-in barrier shall prevent entry of insects into the sensor. The detector shall be designed for fast and simple laboratory cleaning.

The detector shall be inserted into or removed from the base by a simple push-twist mechanism to facilitate exchange for cleaning and maintenance. The manufacturer shall produce and provide test equipment allowing to test and exchange smoke detectors upto 7m (23ft) above floor level. The detector shall connect to the control unit via a fully supervised two-wire circuit.

The detector shall be capable of being remotely tested from control panel.

HEAT DETECTOR (ADDRESSABLE TYPE)

Heat detector shall be combined rate of rise and fixed temperature type. Heat detectors shall consist of two independent thermistors, designed to automatically compensate virtually hermetically sealed to prevent their operation from being impaired by dust, dirt of humidity. All circuitry must be protected against usual electrical transients and protected against usual electrical transients and electromagnetic interference. Reversed polarity or faulty electromagnetic interference. Reversed polarity or faulty zone wiring shall not damage the detector. The detector shall have no moving parts or components subject to wear. It shall be possible to test the detector in the field. The response (activation) of a detector shall be clearly visible from the outside by a flashing light of sufficient brightness. The e detector shall be installed into the base by a simple push-twist mechanism to facilitate exchange for cleaning and maintenance. The detector shall connect to the control unit via a fully supervised two-wire circuit.

The manufacturer shall test equipment allowing to test and exchange rate-of rise/fixed temperature hear detectors up to 7m (23ft) above floor level.

The detector shall be capable of being remotely tested from control panel.

PLUG-IN BASES

The smoke & heat detectors shall fit into a common type of standard base. Once a bases has been installed, it shall be possible to insert, remove and exchange different types of detectors by a simple push-twist movement. The standard base shall be equipped with crewels wiring terminals capable of securing wire sizes upto formation and weakening of contact pressure. The standard base shall be supplied with a sealing plate, preventing dirt, dust, condensation or water from the conduit reaching the wire terminals or the detector contact points. All standard bases shall be supplied with a removable dust cover to protect the contact area during installation and construction phase of the building. It must allow the check out and certification of the zone wiring before insertion of any detectors. The standard base shall feature a built-in mechanism, which allows mechanical locking of as installed detector head, thus preventing unauthorized removal or tempering while maintaining.

The detector contact points shall be designed to retain the detector safely and to ensure uninterrupted contact also when exposed to continuous severe vibration. All electronic components of base and modules must be solid state and virtually hermetically sealed to prevent their operation from being impaired by but, dirt or humidity. All circuitry must be protected against usual electrical transients and electromagnetic interference. Reversed polarity or faulty zone wiring shall not damage the detector. The standard base shall allow snap-on insertion of an (optional) electronic module, it shall be possible to turn a standard base part into an individually addressable detector base with its own unique identification address at the control unit. The standard base shall have a built in alarm indicator which is repeatable by connecting a simple 2 core wire to the base. No changes in the zone wiring shall e required to operate the additional alarm indicator. Removal and insertion of dust covers or detectors shall be feasible by a simple push twist movement, even if the locking device has been activates. Special base assemblies shall be available for use in air ducts and aspiration air-sampling system wherever required.

Contractor is required to submit samples and get approved from Engineer-in-charge of all items like Response Indicators, Hooters, manual call points.

10.0 COMMUNICATION (INTERCOM & LAN)

10.1 The intercom and LAN shall be fully wired in CAT 6 cable, as per approved drawings. The system shall be complete with required conduit and wiring and RJ outlets.

10.2 The telephone handset/instrument inside BSL-3 containment area shall be suitable for true handsfree operation, flushed wall mounted, with complete unit in stainless steel housing.

10.3 The Data and LAN system shall be complete and wired in CAT6 cable laid in separate conduit.

10.4 All the rooms and locations indicated and as approved by the Engineer-in-charge, with voice points shall be provided with telephone handsets

10.5 The Data system shall be complete with following system components, complete as required:

Data outlets, RJ45
4 pair UTP Cat 6 data cable
Uplink using either Cat 6 as per design
Patch panels
Ethernet switches
LIUs
Single mode OFC

10.6 **15U Wall Mount Rack**

15U (550W x 450D) Wall Mount Rack with tinted, toughened Glass door with Lock & Key, PDU, Cable Manager, FAN, Mounting Accessories, Provision for earthing, Grounding and Bonding (Reputed Brand, DIN 41494 OR equivalent ISO Standards)

10.7 **Core Layer 3 10G Switch**

Product Details - Make, Model No / Product Code
I/O Ports & Slots - 12-port 10G SFP+ Switch including 2 10GBASE-T/SFP+ combo ports
Performance - Minimum 512MB or higher RAM, 4MB Packet Buffer, 240Gbps Switching Capacity, 178 Mpps Packet Forwarding,8K or more Mac Address support,

Layer 2 Features - Should support 4K VLAN Groups with 4K configurable VLAN ID, support STP, RSTP, MSTP, Loop Detection in downstream switches, Link aggregation, IGMP Snooping, MLD Snooping, QoS, Port Mirroring, ACL
L3 Services - Min 8 or More SVI / IP Interfaces, ARP / Gratuitous ARP, IPv4 and IPv6 Default & Static Routes
Security - SSH V1/V2, SSL V1/V2/V3, Port Security, IP Source Guard, DHCP Snooping, RADIUS, Port based/Host based 802.1X Authentication, Management access control via Local/Radius
Management - Web-based GUI, Console management, Telnet, SNMP v1/v2c/v3, TFTP or HTTP File transfers, IPv4 / v6 Dual Stack, Syslog, IPv4 and v6 DHCP Relay, LLDP, NTP/SNTP.
Electrical characteristics - Power inlet (AC): 100-240 VAC, 50-60 Hz.
Environmental specifications - Operating Temperature- 0oC to 50oC
Compliance/Certification - CE, FCC, C-Ticket, VCCI, BSMI, CCC
Industry Recognition - OEM should have appeared in Gartner's Magic Quadrant for LAN infrastructure.

10.8 **Cat 6 UTP cable**

Universal labels color coded for T568A/568B, suitable for 23-26 AWG stranded and solid wire, ETL verified unshielded EIA/TIA connecting hardware, Category 6, TIA568 C.2, Contact Bracket - PC, UL 94V-2, Use insulation displacement connectors (IDC), IDC Housing - PC+ Glass Fiber, UL 94V-2, 50 µinches gold on plug contact area, Phosphor bronze with Nickel plated IDC Contact
24-Port Category 6 - Patch panel fully loaded
Powder coated steel in 24 port configuration, should support port identification numbers on the panel, IDC: Suitable for 22-26 AWG stranded and solid wire compatible with both 110 & Krone punch down tools, Cat-6 transmission performance. UL 94V-2, IDC Housing - PC+ Glass Fiber, UL 94V-2

10.9 The incoming telephone lines and internet connections shall be arranged by the Client.

11.0 DOOR INTERLOCK AND ACCESS CONTROL SYSTEM

The door interlock and access control system shall be provided with combination of proximity card based, numerical key pad lock based and push button based system. The system shall be complete with access logic controllers, door electromagnets, proximity cards and card reader/s, numerical keypad locks, door release push buttons, emergency door release buttons, PC communicator, control and power wiring and cabling and other required accessories, hardware, and software.

A suitable software shall be programmed/loaded on the computer to allow performing the following operations.

- Assign the access rights to the individual proximity card holder/s
- Create database for biometric readers for the authorized persons and assign them access rights.
- Enable/disable access for specified time periods (for visitors etc.)
- Record the transactions and generate transaction reports

Proximity Card Reader and Access Logic Controller shall in general meet the following specifications:

No. of doors control per controller	- Minimum 4
Recognition of holidays	- Yes
Anti pass back system	- Yes (system to refuse exit unless there is valid entry)
LCD display on the controller to show status	- Yes
Frequency	- 125 KHZ
Card Reading Time	- Less than 1 second
Output interface	- RS-232 / RS-422 / RS 485
Baud rate	- More than 19000 bps
Power	- 12 to 24 VDC
ID Number	- 1 to 10 digits from keypad or card
Use capacity	- Not less than 100

Access Control Software shall be suitable to operate on the latest Windows OS.

The electromagnetic lock shall conform to the following specifications as minimum.

Holding Force	- Atleast 650 Lb per door
Operating Voltage	- 12/24 VDC or 12/24 VAC
Protect against corrosion	- The electromagnetic lock and its accessories shall be of anticorrosive material/finish
Residual Magnetism	- There should be no residual magnetism after release of Electromagnetic lock

Access Control system in following configuration shall be required:

1 Door System - To control Entry/Exit for restricted access.
2 Door System - To provide interlocked doors with restricted access
3 Door System - To provide interlocked doors with restricted access
4 Door System - Generally for Change-Shower-Change with restricted access

Note : All systems for Change-Shower-Change shall be provided with a privacy switch such that if a person enters the outer change and activates the privacy switch, the channel shall not allow access from either side, till the person deactivates the privacy switch.

The access control system shall be powered through UPS supply for uninterrupted operation even during mains power failure.

12.0 IP BASED CLOSED CIRCUIT TV (CCTV) SYSTEM

General

The system shall offer surveillance using an IP based system to monitor designated locations by installing IP based cameras and live monitoring, recording, playback from central control room with the help of network video recorders, LED monitors, Storage disk of sufficient capacity. The system shall be designed for minimum 2 mega pixels and 30 fps of video management and for a storage capacity of 30 days.

Standards and codes

Products shall comply with UL/ FCC /CE /EN/ BIS /IEC/ONVIF/RoHS standards
Design & Installation guide lines shall be referred from latest NBC/CPWD regulations.

Scope of work

Supply, installation, testing & commissioning of IP based CCTV surveillance system as per the following details:

- IP based dome camera – Refer relevant tender drawings for camera locations
- Network Video Recorders & video management software
- Storage hard disk
- Server PC
- LED display units
- PoE switches
- Patch Panels
- Racks

Network Video Recorder

ANR technology to enhance the storage reliability when the network is disconnected
HD input H.265/H.264+/H.264/MPEG4 video formats
Connectable to the third-party network cameras
No of channels for camera connectivity to be as per design
Recording at up to 12 MP resolution
Supports live view, storage, and playback of the connected camera at up to 12 MP resolution
HD Output
HDMI and VGA outputs provided
HDMI Video output at up to 4K (3840 × 2160) resolution
HD Storage
Up to 4 SATA interfaces connectable for recording and backup
Storage space effectively saved by 50% to 70% with the use of H.264+decoding format
HD Transmission
1 self-adaptive 10M/100M/1000M network interface
8/16 independent PoE network interfaces are provided
Centralized management of IP cameras including configuration, information import/export, real-time information display, two-way audio, upgrade etc.
Connectable to smart IP cameras, recording, playback and backing up of VCA alarms can be realized
VCA detection alarm is supported
Instant playback for assigned channel during multi-channel display mode
Smart search for the selected area in the video and smart playback to improve the playback efficiency
Supports HDD quota and group modes; different capacity can be assigned to different channels

42 inch LED monitor

Screen type	:	LED
Display size	:	42 inch
Panel	:	grade A
Screen resolution	:	1920X1080 pixel, full HD
Aspect ratio	:	16:10
Viewing angle	:	178/178 degrees
Contrast ratio	:	30000:1 dynamic
Colour system	:	PAL/NTSC/SECAM,

Interface : TV, VGA, AV, YPBPR, USB, HDMI & audio input, Audio output,
Type of mounting : Wall mount or table mount kit
PAP facility : Variable
PIP facility : must be provided
Voltage range : 90 to 270 v ac

IP IR Dome/ Bullet camera

Resolution: Minimum 4 MP
Type: Vari focal type, IP networkable, IR LED type
Image sensor: 1/2.7 " CMOS progressive scan or better
Lens: 2.5 to 15 mm or better
IR distance: minimum 30 mtr or better
Frame rate: 25 fps or better
Other features: Motion detection, tampering and defocus detection, Lens distortion support Illumination required: minimum 0.02 lux colour
WDR: Minimum 120 dB
Noise reduction: 3 DNR
Built in micro SD card: Memory slot with 128 GB capacity
Video compression: H 265, H 264, MJPEC codec support
Product compliance: ONVIF/FCC/CE/UL/EN/ROHS
Network protocols: TCP/IP, UDP, DHCP, NTP, RTSP, PPPoE, SMTP, FTP, SNMP, UPnP, Unicast,Multicast, ICMP, HTTP, HTTPS, DNS, DDNS, RTP, RTCP, IGMP, 802.1X, QoS, IPv4,IPv6, ARP
Protection level: Minimum IP66, IK1
PoE: 12 V DC.

13.0 ONLINE UPS (For Critical Lab Systems like BMS, CCTV, Access & IVC's)

Sr. No.	Functionality/ Description	Minimum Specifications
1.	Make	As per approved list of makes
2.	Capacity	30 KVA (Min. capacity- Actual capacity as per approved designs shall be provided)), 3-Phase
3.	Service	Continuous
4.	Waveform	Stepped approximation to a sine wave
5.	Input Voltage	230V AC
6.	Input Connection	India 3 Pin 6A. Power cable to be provided as required
7.	Output Voltage on Mains & Battery	230V
8.	Output Frequency with battery	50Hz ± 5%
9.	Output Ports	3-pin 6A (Surge Protection)

10.	Output Ports	3-pin 6A (Battery Backup) OR more
11.	Operating Temperature	0 - 40 °C or better
12.	Operating Humidity	0 - 90% Non-Condensing or better
13.	Battery Rack	To be provided
14.	Battery Type	Sealed maintenance free and leak- proof
15.	Battery Backup	30 Minutes at full load or better
16.	Charger	Built in
17.	Indicators & Audible Alarm	I) Online II) On Battery III) Low Battery IV) Overload
18.	Accessories	All required cables, connectors & interfaces, mounting arrangement etc. for successful installation, commissioning of UPS
19	BMS compatibility	Modbus/Backnet/RS 485 as per BMS vendor's requiremnt

14.0 OUTDOOR & LANDSCAPE LIGHTING

a) The actual position of all fittings, the wiring details and cable routes shall be coordinated with other services and architectural elements at site and submitted for the approval of the Engineer-In- Charge.

b) The Contractor has to ensure that products being supplied are of high technology, aesthetics and glare free performance and these products meet international guidelines.

c) All technical submissions shall be approved by the Engineer-In-Charge prior to the respective stages of construction with respect to the approved design. In case of major deviations, it shall be brought under the notice of Engineer-In-Charge for its review and approval. The submission shall include the following as a minimum requirement,

i) Equipment catalogues submission with manufacturer's data
ii) Sample submission include all wiring accessories
iii) Shop Drawings of the lighting, circuit numbers, cable routings, switching arrangement, mounting height, etc. The positions and mounting heights shall be coordinated with other services. Fixing details of all wiring accessories shall also be included.
iv) Sensor placement for daylight, presence movement for Street lights and Pole lights only.
v) Drawings showing the installation details

d) Fixtures & Poles types

Pole shall be GI and should have anti-rust coating and PU painted.
Light fitting shall be IP 66 IK 08 with minimum LED wattage of 45-54 W. Fixture housing should be made of Die cast Aluminium, in vandal- resistant V2 self-extinguishing polycarbonate, UV-stabilized Optics.

i) The Lux level for lighting shall be as follows :-

Public Parking – 20-30 lux
Internal Roads – 35-45 lux
Main Approach Roads – 50-60 lux

15.0 INVERTER/UPS (For Lighting backup – 50% Lighting)

Sr. No.	Functionality/ Description	Minimum Specifications
1.	Make	As per approved list of makes
2.	Capacity	5 KVA (Min. capacity- Actual capacity as per approved designs shall be provided)), 3-Phase
3.	Service	Continuous
4.	Waveform	Stepped approximation to a sine wave
5.	Input Voltage	230V AC
6.	Input Connection	3 Pin 6A. Power cable to be provided as required
7.	Output Voltage on Mains & Battery	230V
8.	Output Frequency with battery	50Hz ± 5%
9.	Output Ports	3-pin 6A (Surge Protection)
10.	Output Ports	3-pin 6A (Battery Backup) OR more
11.	Operating Temperature	0 - 40 °C or better
12.	Operating Humidity	0 - 90% Non-Condensing or better
13.	Battery Rack	To be provided
14.	Battery Type	Sealed maintenance free and leak- proof
15.	Battery Backup	30 Minutes at full load or better
16.	Charger	Built in
17.	Indicators & Audible Alarm	I) Online II) On Battery III) Low Battery IV) Overload
18.	Accessories	All required cables, connectors & interfaces, mounting arrangement etc. for successful installation, commissioning of Inverter
19	BMS compatibility	Modbus/Backnet/RS 485 as per BMS vendor's requiremnt

16.0 DIESEL GENERATING SET

16.1 SCOPE

a) The scope shall cover complete supply, installation, testing and commissioning of direct radiator cooled diesel engine alternator set. All minor civil works, electrical and other works associated with the testing, installation and commissioning of the sets shall be carried out by the contractor
b) Fuel Oil System from day tank to engine.
c) Lube Oil System and speed governing system.
d) Alternator with excitation system and automatic voltage regulator (AVR) and necessary protection and metering CT's in terminal box of alternator.
e) Radiator cooling.
f) Acoustically Treated DG Set Enclosure.
g) Erection/testing and final checking up of the installation at site,commissioning.

16.2 CODES & STANDARDS

The construction, manufacture, inspection, testing and performance shall comply with all the currently applicable statutes, safety codes, relevant Bureau of Indian Standards (BIS) British Standards (BS), International ElectroTechnical Commission (IEC) Publication, NEMA, VDE and DEMA Standards.

Some of the applicable Standards are listed below:-

IS 1601	:	Performance and testing of 1C engines for General Purpose.
BS-649	:	Performance and testing of diesel engines for General Purpose.
IS-4722	:	Rotating electrical machines.
IS-4889:		Method of determination of efficiency of Rotating Electrical Machinery.
IS-6491	:	Degree of protection provided by enclosures for Rotating Electrical machinery.
IS-4729	:	Measurement and evaluation of vibration of Rotating Electrical Machines.
AIEE-606 (1959)	:	Recommended specification for speed governing of internal combustion engine generator units
IS-2705	:	Current transformers.
IS-1248	:	Electrical indicating instruments.
ISO-8528 Section (Part II)	:	Reciprocating IC engine driven AC Gensets

16.3 The DG set shall be silent type, water cooled with radiator, manually and automatically operated, designed for continuous operation at 100% load at 100% time duty operation except the time required for periodic maintenance as per relevant IS/BS 5514. The DG set shall comprise of diesel engine, coupled to four pole alternator on a single frame with integrated microprocessor based genset monitoring and control system having self regulated, brushless/static excitation system.

16.4 All equipment shall be of the class most suitable for working under the conditions specified and shall withstand the atmospheric conditions without deterioration.

16.5 PERFORMANCE REQUIREMENT

a) The equipment shall be capable of delivering continuously at the generator terminals, 100% output at 100% load at 100% time except for periodical maintenance when operating under the site and ambient conditions described in this specification as per relevant IS/BS 5514. Genset should have a minimum 50% single step loading capacity and it should be able to take full load within 25 seconds from start.

The design parameters of the generator and excitation system shall be so chosen, that the set is stable while running at any load between no-load and full load. It should have isochronous speed control with load sensing governing system and should be capable of paralleling between sets at isochronous speed.

b) Engine should be heavy duty four stroke, turbo charged after cooled, V construction Electrical start. Engine should have a minimum lub oil change period of 500 hrs..

c) The DG set should be capable of running at 100% load continuously for a minimum 500 hours before any change of lube oil or filters.

16.6 DIESEL ENGINE – CONSTRUCTION

i) Material of construction of major parts.

a) M.S. Base Frame
b) Crankcase - Aluminium alloys or as per manufacturer design.
c) Crank - Shaft, connecting rods - forged alloy steel
d) Piston - Al. Alloy casting
e) Piston rings - Alloy steel
f) Engine block - cast iron or as per manufacturers design.
g) Cylinder liner - cast iron

All other materials of construction for pipe/pipe fittings etc. shall be as per relevant standards.

ii) One common base frame shall be provided for mounting the engine and alternator, complete with electric suspension between generating set and foundation, leveling lines etc. as required.

iii) All externally mounted hardware shall be high tensile steel only.

iv) The normal speed of the engine shall preferably be 1500 RPM and the direction of rotation shall be clearly marked on the set.

v) The engine shall be fitted with an exhaust gas driven turbocharger complete with its own self contained lubrication system. The turbo charger shall be positioned at the free end of the engine. The turbo charger will be provided with a provision to check its lube oil level.

vi) The engine shall be fitted with a charge air intercooler. Air from the turbocharger compressor passes through the inter cooler and then to the engine manifold. The intercooler shall be of tubular construction or as per manufacturer design with aluminium bronze tubes, mild sheet steel and cast iron water heaters.

vii) The engine shall be capable of starting and operating for a few minutes without supply of water for cooling. Contractor shall indicate the maximum time for which the diesel engine can operate.

16.7 FUEL OIL SYSTEM

i) The manufacturer shall furnish a 3 mm thick mild steel day tank of 990 ltr. capacity. The day tank shall be suitably located in the acoustic enclosure and shall be complete with gauge glasses, filling, draining and vent connection with brass float valve and level switch for low and high level alarm.

ii) The fuel oil system shall be provided with a full flow simplex oil cartridge filter.

iii) The fuel oil system shall be equipped with a crankshaft driven fuel oil transfer pump, which will draw the fuel oil from the day tank via filters and shall be as per the engine manufacturer design.

iv) Direct injection systems shall be designed, taking into account the type of fuel used, engine speed, etc. so as to achieve safe knock free performance with low emission smoke exhaust. Exhaust system pollution level shall be indicated and has to be approved by concerned authorities.

v) The interconnected piping from day storage tank to engine together with piping, fitting, relief valves, return line of surplus oil from the injectors and other accessories shall be supplied & erected by the contractor without any extra charge.

vi) Engine will be supplied with a fuel leakage module to detect the fuel leakage from the engine and transfer it back to the day tank for reuse.

16.8 LUBRICATING OIL SYSTEM

i) All lubricating parts of the engine shall be connected to pressurized lubricating oil distributing piping systems being continuously charged by gear type lube oil pump mounted at the free end of the engine, and driven from the engine crankshaft. The pumps shall take suction from a sump tank integral with the engine through a foot valve, suction filter through oil cooler, and deliver oil to a main supply header. High pressure oil shall be supplied to the main and big end bearings, crankshaft bearings, governor, auxiliary drive gear etc. Suitable lubricating arrangement for engine cylinder valve gear, cams and pistons at the required level shall be arranged. A pressure relief valve shall be mounted on the main supply header for safety against too high pressure while starting with cold oil. A timer based auto running (auto priming pump) shall be provided to keep the engine lubricated all the time.

ii) All necessary accessories such as pressure gauges, temperature indicators, pressure relief valves, bypass valves; pressure switches shall be furnished within the contract without any extra charge.

16.9 ENGINE STARTING SYSTEM

The electric starting system shall comprise starter motor, starter batteries (minimum 2 No. of 180AH each) and battery charger and all the required instrument and accessories as required.

16.10 GOVERNING SYSTEM

The governor shall be electronic type.

16.11 EXHAUST SYSTEM

Engine exhaust system shall be fitted with residential type silencer; ducting, bends, thermally insulated aluminium clad exhaust piping etc. shall be provided along with structural support with stays for the engine.

16.12 ENGINE MOUNTED INSTRUMENT PANEL

Engine will be supplied with an engine mounted microprocessor based fully integrated generating set monitoring, metering and control system which should be equipped with digital electronic governor along with digital AVR to facilitate discreet control of speed and voltage. It should be equipped with starting control including integrated fuel ramping to limit the black smoke frequency overshoot with optimized cold weather starting. The indicating panel should have a communication network facility to facilitate remote hooking on a common network. Engine instrument panel should be equipped with a digital alarm and status mirage to monitor and display the following parameters of engine and generator.

Engine Indicators

Digital tachometer
Running hours counter
Starting attempts counter
Lube Oil pressure low (for idle and for rated speed)
Lube Oil temperature high
Coolant temperature high
Exhaust gas temperature high
Over speed

Electrical Indicators

3 x current
3 x voltage
Frequency
Active power
Reactive power
Power factor
Frequency totalizer
Battery voltmeter

Signal alarms

Control panel fault

24 Vdc fault
Failure to start
Fuel day tank level low
Battery low voltage

Controls and selectors

Operating mode selector switch (stop, manual, auto, test)
Start/stop pushbuttons
Manual control selector switch (idle, rated, synchro, loading)
Emergency stop pushbutton
Fault reset pushbutton

16.13 ALTERNATOR

a) The alternator shall be industrial type, SPDP, IP23, Class H insulation, self ventilated, air cooled, rotating field, salient pole, brushless, machine with exciter and shall be rated continuous duty with temperature rise class H. The alternator should comply to standard IEC, VDE, BS, ANSI.

b) The alternator shall have a continuous rating of not less than the value specified under specific requirement in Annexure-I at 0.8 pf (lag) and the voltage specified.

c) The short circuit ratio (SCR) of the generator at rated KVA and rated voltage shall not be less than 0.5.

d) The alternator shall withstand without mechanical damage an over speed of 20% for a period of 2 minutes.

e) The alternator shall be capable of withstanding without damage/injury for three times the line current for 10 seconds.

f) The alternator shall be capable of withstanding for fifteen (15) seconds. A current of fifty (50) percent in excess of its rated current, the voltage being maintained as near the rated value as possible, consistent with max. capacity of the prime mover.

g) Six nos. embedded PT-100 of platinum to measure the winding temperature and 2 nos bearing PT-100 to measure temperature shall be provided.

h) The leads of embedded WTDs shall be wired upto the terminal block in a separate terminal box. Manufacturer shall indicate the setting values for each WTD/BTD for alarm and trip.

i) Online greasing facilities with grease nipples and grease relief devices shall be provided.

j) All external nuts and bolts shall be of high tensile steel only.

k) Alternator shall be provided with anti-condensation space heater of adequate rating suitable for 240V, 50 Hz, 1ph A.C. supply and shall be wired upto a separate terminal box.

l) Two independent earth terminals on the frame, complete with nuts, spring washer and plain washer shall be provided.

m) Alternators shall be provided with a suitable terminal box for terminating the bus duct. Suitable arrangement shall be provided in the terminal box for formation of star point for alternator neutral earthing.

n) The alternator should be capable to sustain the unbalanced current between the phases upto minimum 25% of rated current.

o) The radio interference should be within the limit of the CISPR standard.

p) Alternator should be dynamically balanced complete with rotor and shaft.

q) The alternator should have double long life regreasible bearing. It should be flanged on the engine, connected with elastic coupling.

r) The Alternator shall be capable of handling at least 50% non-linear load.

16.14 EXCITATION SYSTEM

a) The alternator shall be provided with a complete diode type brushless excitation system, capable of supplying the excitation current of the generator under all conditions of output from no load to full load and capable of maintaining voltage of the generator constant at one particular value.

b) The exciter shall have class-H insulation.

c) The excitation system shall comprise a shaft driven AC exciter with rotating rectifiers. The rectifiers shall have in-built protection for over-voltage.

d) The alternator should be complete with shunt and booster excitation. The exciter shall be fast response type and shall be designed to have a low time constant to minimize voltage transients under severe load changes. The excitation voltage response ratio shall be at least 0.8.

e) The rated current of the main exciter shall be at least 10% more than the alternator rated exciter current and it shall have a 40% overload capability for 10 seconds.

f) No external supply shall be required during starting and normal running of the alternator.

16.16 AUTOMATIC VOLTAGE REGULATOR

a) An automatic high speed, dead band type voltage regulator shall be provided complete with all accessories. The regulation system shall be provided with equipment for automatic and manual control.

b) The regulator shall regulate the output voltage from generator current and potential signals. Series compounding transformer shall be provided to enable maintaining adequate terminal voltage in the event of terminal faults. Alternatively excitation system shall be provided with arrangement for field forcing. Contractor shall co-ordinate suitable of protection relays for

generator with the operational characteristics of automatic voltage regulator, specially under short circuit conditions.

c) Voltage regulation and steady stage modulation shall be within + 1% of the line voltage with manual voltage adjustment capability within + 5%.

d) Necessary equipment for field suppression and surge protection shall be provided.

e) The response time of the exciter and the generator shall be properly matched to avoid hunting.

f) AVR system shall be provided with equipment for automatic and remote operation/control as required.

g) Necessary equipment shall be furnished for the following :-

i) To prevent automatic rise of field voltage incase of failure of potential supply.
ii) To initiate transfer from automatic to manual control of excitation on fuse failure in the generator potential signal. Circuit to assure correct division of reactive power for parallel operation. The excitation and voltage regulation shall be designed to cause necessary de-excitation in case of short circuit. Cross current compensation circuit shall be provided.

16.17 PAINTING

a) All steel surfaces, which are to be painted, shall be thoroughly cleaned, degreased and supplied with primer prior to assembly and shall be applied with two coats of epoxy paint shade RAL 7032 as per IS5.

b) All castings shall be sand blasted, degreased and cleaned before painting.

16.18 TESTS

Following tests shall be carried out at the engine manufacturer's works in the presence of Engineer-in-charge or his representative, if so desired.

DG set and the auxiliaries shall be assembled at the manufacturer's works and the following tests shall be performed.

a) One (1) hour at full load with fuel consumption
b) One (1) hour at 3/4 load with fuel consumption
c) One (1) hour at 50% load with fuel consumption
d) Four (4) hours at full load followed by a 1 hour continuous load at 110% and with fuel consumption.

Before each test, the engine shall be brought to a steady state under the conditions of the test.

The alternator shall be subjected to following routine tests As per IS :

a) Measurement of resistance of stator and rotor windings
b) Insulation resistance of stator and rotor windings

c) High voltage tests on stator and rotor windings
d) Open circuit and short circuit tests
e) Temperature rise test
f) Regulation test

VOLTAGE REGULATOR

a) Sensitivity test
b) Response time test

TEST AT SITE

a) The tests shall be performed after proper installation of the diesel generating unit at site to prove the proper operation of interlock circuits and the capability of the engine to start and pick-up load in the specified time, under supervision of the employer representative responsible for supervision, testing and commissioning.
b) Guarantee tests to prove guaranteed performance of the DG set shall also be carried out at site after proper installation. The load test with available load at site will be given for about 8 hours.

16.19 TEST CERTIFICATE

a) Test certificate shall be submitted in three (3) copies.
b) The test reports shall furnish complete identification of the data, including serial number of each equipment.

16.20 GUARANTEED PERFORMANCE

The contractor shall furnish, along with the offer the technical particulars as called in the Annexures. The performance figures quoted in the technical particulars sheet shall be guaranteed with the tolerance permitted by relevant standards

16.21 SYSTEM OPERATION:

Automatic Mode

While the normal mains supply is healthy the diesel alternator set will be at rest and the load will be supplied by the mains.

The AMF system shall monitor the main supply voltage & when the main supply voltage drops below a certain preset value, the system shall sense these conditions & shall give automatic start command to the control systems.

After a time delay of 1.5 seconds from the main supply failure the diesel engine shall start.

When the DG set attains its rated speed and voltage a closing signal shall be given to the ACB of the DG set.

When the voltage in the mains gets restored, its quality is monitored for about one minute and if proven satisfactory the main supply breaker shall close automatically for transfer of the load from Diesel engine to the main supply at L.T. Panel.

The set shall stop after idle running of one minute after restoration of main supply.

The diesel alternator set reverts to its standby conditions &its ready to start should the mains supply fail again.

16.22 TECHNICAL PARTICULARS OF DIESEL GENERATOR SETS

1.	Quantity and rating	:	1 No x 400 KVA Diesel Generator unit (Estimated capacity – Actual capacity as per approved design shall be provided)
2.	Mode of operation	:	Auto/ Manual start
3.	Alternator		
3.1	Output rating at 0.8 p.f. (lag)	:	400 kVA (at site conditions) continues output at 100% load and of 50°C at 100% time except at the time of periodic maintenance.
3.2	Class of insulation for Stator & Rotor	:	Class H
3.3	Rated voltage & frequency	:	415 V, 50 Hz
3.4	Maximum permissible time for Building up rated voltage From stand still	:	Less than 20 seconds
3.5	Variation of voltage from No load to full load	:	±5% of rated voltage
3.6	Frequency variation	:	± 1%
3.7	Capacity of largest rating Motor starting	:	To be furnished
3.7.1	Dynamic voltage response & permissible voltage drop during largest rating motor starting	:	Less than 15% of rated voltage under operating condition at 3.6 above.
3.8	Temperature detectors	:	6 nos. RTD and 2 nos. BTD of type PT-100 for winding temperature and bearing temperature measurements
3.9	Type of excitation system	:	Brushless, shunt and booster
3.10	Type of control for voltage regulator.	:	Automatic

4.0	Type of fuel for engine	:	High speed diesel according to IS 1460 & as approved by the Central Pollution Control Board.
4.1	Day oil tank capacity	:	Capacity of tank 990 lts.
4.2	Lube Oil	:	Viscosity SAE-40
4.3	Maximum permissible starting Starting time for attaining Full speed	:	Less than 20 Seconds
4.4	Engine starting	:	Electric starting system
4.5	Type of governor	:	Electronic class A1 (Electronic Isynchronics Governor)
4.6	Lubricating system	:	Pressure fed type
4.7	Cooling system	:	Radiator cooling
4.8	Engine cranking system	:	To be included

16.23 SOUND ATTENUATED ACOUSTIC ENCLOSURE

A suitable **"SOUND ATTENUATED" ACOUSTIC ENCLOSURE"** to provide high level of **"NOISE REDUCTION"** shall be provided to house the D.G. Set.

ACOUSTIC ENCLOSURE

The acoustic enclosure housing for the diesel generating set shall be designed on the best engineering practice. It should have aesthetic looks and bring down sound noise to 75 dB when measured from a distance of 1 meters away from the DG Set as per noise pollution norms.

Enclosure construction shall be fully bolted keeping in view the major service requirements all doors shall be provided with specially designed hinges and lockable handles, Battery, Fuel tank and ACB shall be housed inside the enclosure.

The DG Set shall be supported on a base frame in CRCA Sheet enclosure with suitable ducting for air inlet and outlet. The enclosure frame shall be of rectangular steel tubes. The doors & enclosure is treated and painted with duco paint for longer life and weather proof. Requisite air circulation for heat dissipation and combustion shall be provided by axial fans. All oil & fuel connections shall be through steel braided pipes for fuel safety reasons.

The acoustic enclosure consists of the following:-

ACOUSTIC INSULATION

High density resin bonded glass wool shall be provided on all five sides including doors and roof to absorb noise.

Resin bonded Rockwool of high density (as per manufacturer's standard) with minimum 100 mm thickness with tissue paper (min 50 gm/sq.m) covered with perforated 1.6 mm painted MS sheet shall be used as sound absorption material on all five sides including doors is provided. The air ducts shall also be covered with mineral wool.

Acoustic hoods with noise splitters provided to block and reduce the sound leakage

16.24 EXHAUST SYSTEM

The exhaust gas is taken out of enclosure through suitable size class C MS pipe (minimum 3.25m higher than the enclosure) and noise suppressor duly insulated with 50 mm rockwool insulation, 24 G Aluminium cladding.

16.25 AIR CIRCULATION AND VENTILATION SYSTEM

Proper care shall be taken for engine heat rejection to ensure safe working temperature inside the enclosure. Requisite air circulation shall be provided by means of required nos. of axial flow fans with GEC, NGEF, Crompton, ABB make motors of required capacity with downstream flow silencer. The Air Circulation system shall ensure that the temperature rise inside the enclosure is never more than 5 deg C above the ambient temperature.

A suitably designed residential type noise suppressor complete with acoustic and thermal insulation shall be provided.

16.26 FUEL TANK AND BATTERY SYSTEM

The enclosure shall be provided with separate chambers for fuel storage tank and battery storage for safety purpose.

16.27 ARRANGEMENTS

The engine and alternator are coupled by means of a flexible coupling and both the units including the radiator shall be mounted on rigid fabricated base frame to form a compact arrangement of the equipment. Base frame shall be of MS steel and suitably machined to ensure perfect alignment and alternator with rigid construction to ensure minimum vibrations.

The complete enclosure shall be detachable which can be dismantled in parts of its easy installation anywhere.

16.28 PAINTING

The acoustic enclosure shall be painted with good quality Duco Automotive paint with a prior red oxide primer base and other protection for making it suitable for installation in open areas.

16.29 VIBRATION ISOLATION

To avoid transfer of vibration from genset to enclosure & surrounding specially designed Spring Type vibration isolators shall be used.

16.30 SAFETIES

The enclosure shall have the following safeties;

a) High Enclosure Temperature
b) Emergency Stop Push button outside the enclosure.

The enclosure shall also be provided with space heater complete with thermostat and controlling ELCB working on 220 V A.C. supply and chamber illumination lamp working on 24 V DC supply.

17.0 LIFTS

1.0 General

1.1 This specification covers manufacture, testing as may be necessary before dispatch, delivery at site, all preparatory work, assembly and installations, commissioning putting into operation of Lifts.

1.2 **Location**

1No.Passenger Lift in BSL-3 Laboratory building at IAV, Kerala, Thiruvananthapuram, Kerala.

1.3 The work shall be executed as per CPWD General Specifications for Electrical Works (Part III Lifts & Escalators – 2003) as per relevant IS and as per directions of Engineer-in-Charge. These additional specifications are to be read in conjunction with above and in case of variations; specification given in this Additional conditions shall apply. However, nothing extra shall be paid on account of these additional specifications & conditions as the same are to be read along with the schedule of quantities for the work.

2.0 Passenger lifts –

1.	Type	Passenger Elevator
2.	Number of lifts required	As per finalied layout and drawing
3.	Load:	6 Passenger
4.	Rated speed	1.0 Meter per second
5.	Travel in meter	10.00 Mtrs (Max)
6.	Numbers of floors served	G+1
7.	Location	Inside size of lift well Pit Depth
	Proposed BSL-3 Laboratory Facility at IAV	To be designed as per lift manufacturer
8.	Clear inside size of lift car:	As per manufacturer's standards
9.	Dimension of lift machine room	As per architecture.

		(To be designed as per lift manufacturer)
10.	Position of counter weight	At the sides
11.	Position of machine room	Machine Room Less
12.	a) Type of control	Microprocessor based AC variable voltage variable frequency. (Lift drive motor and controller shall be suitable for operation with supply voltage variation between + 10% to – 10%)
	b) Type of operation	Duplex collective selective operation with/ without an attendant.
	c) Potential free contacts	Potential free contacts for each floor position and up and down movement of the lift shall be provided in the controller which can be used for the building automation system at a later date.
13.	Car entrance door a) Number	One
	b) Size	As per manufacturer
	c) Type of doors	Power operated, Horizontal sliding – center opening
	d) Car open in front only	Yes,
14.	Lift Car	
	I) Construction design	As per General specification for electrical works (Part-III-Lifts & Escalator) – 2003
	II) Interior Finish	
	i) Panels	The sides and facia panel shall be scratch proof honeycomb/moon rock finish) of stainless steel sheet.
	ii) Flooring	Suitable decorative flooring as per the standard design of manufactures for passenger lifts.
	iii) Ceiling	SS ceiling as per the latest standards of the manufacturer.
	iv) Lighting	LED Fitting as per standard design
	v) Ventilation	Suitable ventilation in the ceiling.
15.	Type of signal system	a) Digital floor position indicator in the car and at all landings (to be provided above the car/landing doors) b) Travel direction indicator in the car and at all landings (to be provided above the car/ landing doors)

c) Gongs & visual indication on all landings for pre arrival of the car for two or more cars.

d) Overload warning Audio & Visual indicator, inside the car (lift should not start on overload)

e) Battery operated alarm bell and emergency light.

f) Car operating panel with fade proof luminous buttons with additional brail inscriptions in car and with intercom

g) Luminous hall buttons with additional brail inscriptions at all landings.

h) Fireman's switch at ground floor.

16. Landing entrance

a) Locations of landing entrance on different floors.	All doors on the same side.
b) Number	As per No. of stops
c) Size	As per manufacturer
d) Type of doors	Power operated, Horizontal sliding – center opening
e) Lift in use/lift out of order sign	A suitable box above the lift landing with LED illuminated bilingual (in English & Hindi) sign of "LIFT OUT OF ORDER" coming up simultaneously at all floors.
f) Fire resistant rating of the door	Shall not be less than one hours.

17. Electric Supply

a) Power: - 415 V±10%, AC, 3Phase, 50 Hz, 4 wire system.

b) Lighting: 230 V, AC, 50 Hz

c) The entire lift equipment should be suitable for operation at +10% to - 10% of the rated supply wanted.

18. Emergency Supply

i) Inverter backup with trickle/boost charges arrangement for at least 30 minutes with maintenance free batteries for emergency light, alarm bell and inter-com system.

ii) A separate maintenance free battery system should be provided for Automatic Rescue Device (ARD)

19.	Door Close Safety	Full height Infrared light curtain door safety in addition to a pressure operated switch (mechanical safety switch)
20.	Controller Panel gauge	i) The controller panel shall be of suitable steel having Vermin/dust proof arrangements with suitable in built ventilation system.
21.	To Automatic Rescue Device	i) Automatic Rescue Device (ARD) should monitor the normal power supply in the main controller and shall activate rescue operations within ten seconds of normal power supply failure. It should bring the elevator to the nearest floor at a slower speed than the normal run. While proceeding to the nearest floor the elevator will detect the zone and stop. After the elevator has stopped, it automatically opens the doors and parks with door open. After the operation is completed by the ARD the elevator is automatically switched over to normal operations as soon as normal power supply resumes. ii) All the lift safeties shall remain active during the ARD mode of operation. iii) The battery capacity should be adequate so as to operate the ARD at least seven times a day. Provided the duration between usages is at least 30 minutes.

SECTION - III

TECHNICAL SPECIFICATIONS FOR HVAC & ASSOCIATED WORK

1.0 TECHNICAL SPECIFICATIONS - HVAC SYSTEM

1.1A.GENERAL

Scope of work shall include design, engineering, supply, installation, testing & commissioning of HVAC systems. All material shall be conforming to relevant IS specifications wherever exists and subject to approval of the Engineer in charge. The HVAC system shall be carried out strictly as per NBC -2016/ASHRAE/ISHRAE/CPWD/ECBC latest versions.

Note: All work shall be carried out as per the given technical specification in this tender, however any items missed out which are required to complete the work shall be carried out

strictly as per latest CPWD specification/ ASHARE/ DBT/ relevant IS standard with up-to-date correction slip.

1.1.DRAWINGS

The contractor on award of work will furnish detailed stage-wise GFC drawings as required in advance for approval of Engineer-In-charge.

1.2.GOOD FOR CONSTRUCTION DRAWINGS/ TECHNICAL DATA SHEETS

The contractor shall prepare and furnish all shop drawings including floor plans & Terrace, Schematic HVAC Layout/External HVAC pipe routing etc.

The manufacturing of equipment shall be commenced only after the shop drawings/GA Drawings/ technical data sheet along with pump curves are approved in writing by the Engineer-in-chrage. Such drawings shall be co-ordinated with other services work. These shop drawings will be approved by HITES which will be considered as a base for execution of HVAC work.

1.3.COMPLETION / AS BUILT DRAWINGS

On completion of the work and before issuance of certificate of virtual completion, the contractor shall submit to the Engineer -in-Charge, General layout drawings, drawn at approved scale indicating layout of pump house piping and its accessories as installed.AS built drawings shall be prepared taking approved shop drawings as base & incorporating all changes/ modifications as per site conditions. These drawings shall include the following:-

a. General Layout of Plant Room including all details mentioned in clause 1.2

b. Panels and other equipment/accessories location and their dimensions etc.

c. HVAC floor layout including terrace Plan etc.

d. Complete schematic as installed.

e. Route of all cables and pipes run along with detail sizes and mode of installation.

1.4.DRAWINGS & DOCUMENTS

The contractor shall submit to the Engineer-in-charge, the following documents on completion of the work and before issuance of virtual completion.

a)Warranty for required equipment installed like Pumps, Panels, Chillers, Cooling Tower,

HWG, AHU,FCU etc.

b)As Built Drawings

c)Material Test Certificates

d)Catalogues/Brochures

e)Operation and Maintenance Manuals

f)List of recommended spares and consumables

g)All approvals including technical approvals and sanctions

h)NoC from Fire authority before commencement of execution & after completion of the entire work etc.

1.5.MANUFACTURING

The responsibility for ensuring the manufacture of the equipment as per the specifications shall be solely that of the contractor. The contractor shall be responsible for selection of materials as per agreed specifications.

1.6.MAKE OF MATRIALS/MANUFACTURER'S INSTRUCTION

Only approved makes as mentioned in our approved make list of tender documents of material shall be used. The Contractor shall furnish Technical data sheets / GA drawings of all items before placing P.O. The contractor shall get the samples of required items approved from the HITES as conveyed by E-I-C before commencing the supply. In case of any discrepancy/anomalies w.r.t specifications, prior intimation from Contractor to E-I-C to be given. Final decision lies with HITES for according approvals.

Any specific instruction furnished by the manufacturer covering the points not mentioned in technical specifications of the tender shall be brought to the notice of E-I-C in writing for further instructions in this regard at appropriate time.

1.7.MATERIAL TESTING

The E-I-C shall have full power to get any material of work to be tested by an independent agency at contractor‘s expense in order to prove the soundness and adequacy.

1.8.INSPECTION AND TESTING

a)All equipment shall be inspected and tested as per an agreed Quality Assurance Planbefore the same is packed and dispatched from the contractor‘s works. The contractor shall carry out tests as specified/ directed by Engineer-in-charge.

b)The Engineer-in-chragemay, at his sole discretion, carry out inspection at different stages during manufacturing and final testing after manufacturing.

c)Approvals or passing of any inspection by the engineer or his authorized representativeshall not, however, prejudice the right of the engineer to reject the plan if it does not comply with the specification when erected or give complete satisfaction in service.

d) Tests at Factory:

At least one chiller shall be tested on AHRI/Eurovent certified test bed(test bed capacity >= chiller capacity) at 100%, 75%, 50% and 25% load to establish stable operation at constant entry condenser water temperature of 90° F at the manufacturer’s works and shall be witnessed by client and consultant’s representatives at factory. Client will also witness harmonics voltage and current less than 5%. Chiller shall also be tested at 100% load with 60 deg F condenser entry temperature continuously for 30 minutes. All expenses including the expenses of client & Consultant representatives shall be included in the cost. Nothing extra shall be paid in this regard.

1.9.TRAINING OF DEPARTMENT PERSONNEL

a)The contractor shall train the CLIENT/ HITES‘s personnel to become proficient in

operating the equipment installed. Training shall be done before the expiry of the defects liability period (one year after completion & handing over).

b)The period of training shall be adequate and mutually agreed upon by the Engineer-in-

charge and contractor.

c)The CLIENT/ HITES‘s personnel shall also be trained for routine maintenance work and lubrication, overhauling, adjustments, testing, minor repairs and replacement.

d)Nothing extra shall be paid to the contractor for training CLIENT/ HITES‘s personnel.

1.10. PERFORMANCE GUARANTEE

At the close of the work and before issue of final certificate of virtual completion by the engineer, the contractor shall furnish written guarantee indemnifying the CLIENT/ HITES against defective materials and workmanship for a period of one year after completion and handing over. The contractor shall hold himself fully responsible for reinstallation or replace free of cost to the CLIENT/ HITES.

·Any defective material or equipment supplied by the contractor.

·Any material or equipment supplied by the CLIENT/ HITES which is proved to be damaged or destroyed as a result of defective workmanship by the contractor.

2.0 AIR COOLED CHILLER

a) SCOPE

The scope of this section comprises the supply, erection, testing and commissioning of 3 Nos (2 W+1S) x 60 TR Capacity (Estimated minimum capacity). The contractor shall provide chillers as per final approved designs. The air cooled chillers shall conform to these Specifications and in accordance with requirements.

b) COMPRESSOR

Packaged Liquid Chillers shall be complete with multiple Hermetic Scroll compressors. The compressor motor shall be hermetic, refrigerant gas cooled with inherent all phase protection and shall be suitable for 380-420 Volts, 3 Phase, 50 Hz operation. The maximum KW/Tr shall be around 1.2 at ARI conditions.

c) COOLER

The Shell & Tube Cooler shall be direct expansion type with refrigerant in the tubes & chilled liquid in the shell. The tubes used shall be 5/8” OD, high efficiency inner grooved tubes. Refrigerant heads are removable. The Refrigerant shall be R407C/R410A/Equivalent.

d) AIR COOLED CONDENSER

I) Material and construction- The condenser coil shall be fabricated of seamless hard drawn copper tubes and Aluminum fins of 0.18 mm minimum thickness, fins spacing ranging from 3 to 5 fins per cm. The minimum wall thickness of tubes shall be 1.0 mm.

II) The coil shall normally be 2/3/4 rows deep unless otherwise specified.

III) The condenser shall be designed so as to hold 1.25 times the refrigerant charge in the system during the idle periods.

IV) Suitable number and capacity of propeller type fans shall be provided for moving the air through the entire condenser coils. For more uniform flow over the condenser coil, the condenser shall be designed on the draw through principle.

e) CONNECTION AND ACCESSORIES

The following connections and accessories shall be provided on the condenser and conforming to Section "Refrigeration Piping" where applicable:
Hot gas inlet and liquid outlet connections. The liquid outlet connections shall be provided with isolating valves, Pressure relief device.

The pressure testing shall be done at 31 kg/sq.cm. on the refrigerant side.

f) CONTROL CENTRE

The control centre shall include a high and low-pressure protection & mini circuit breaker for each compressor. The panel shall also contain thermostats & an electronic temperature controller for chilled water temperature control, Antifreeze thermostats for cooler protection, control wiring, pressure gauges and indicator lights. The service doors shall be provided with transparent windows to view the indicator lights & pressure gauges.

g) INSULATION

The Cooler & Suction lines shall be insulated with adequate thickness of foam rubber or equivalent insulating material to prevent condensation.

h) The complete unit shall be finished painted at the factory after assembly.

i) The work shall include chiller foundation, vibration isolation pads and accessories complete as required

3.0 CHILLED WATER PUMP

Pumps shall be as per IS:1520-1660, IS:9079,IS:325 and shall be of the following construction:

Sl.No. Pump Description Horizontal Split Casing

1. Casing : Cast Iron as per IS :210; grade FG260
2. Impeller : Bronze as per IS : 318;
   Impeller ring :Bronze
3. Shaft : High Tensile steel -EN8 or SS 410
   Shaft sleeve : Stainless steel or Bronze

4.	Bearings	: Heavy duty Ball/Roller Bearings.
5.	Base Plate	: Cast Iron
6.	Flanges	: Conforming to I.S.1536/1960
7.	Seal	: Mechanical
8.	Max. Speed	: 1500 RPM
9.	Driver	: T.E.F.C.
10.	Duty	:As per requirement
11.	Qty	: 3 Nos. (2 W + 1 S)

Pumps of a particular category shall be identical and shall be suitable for parallel operation with equal load division. Components of identical pumps shall be interchangeable.

Impeller shall be made in one piece and securely keyed to the shaft. Measures to prevent loosening during operation including rotation in the reverse direction shall be provided. The critical speed of the pump shall be at least 30% above the rated speed. All the pumps shall be provided with mechanical seals. Common base plate shall be provided for the pump and motor. Suitable holes shall be provided for grouting and these shall be so located that the base can be grouted in place without disturbing the pump and the motor. Adequate space shall be provided between pump drain connection and base plate for installation of minimum 15mm dia. drain piping. Foundation bolts shall be complete with nuts and washers. Driver ratings shown are only tentative and contractors shall select their drivers at least 15% in excess of the maximum B.H.P of the pump plus transmission losses if any. Drivers shall be supplied with starters unless otherwise stated. Pump and driver shall be mounted on a single bed-plate and directly driven through flexible coupling in case of horizontal split casing pumps.

The following accessories shall be provided with each pump among other standard accessories:

Coupling guard for horizontal split casing pumps.
Lubrication fittings and seal piping.
Test and/or air vent cocks.

4.0 DOUBLE SKINNED AIR HANDLING UNITS

The AHU Unit performance, coil performance and Mechanical characteristics shall be EUROVENT Certified.

4.1 CASING

The housing/ casing of the air handling unit shall be of double skin construction. The housing shall be so made that it can be delivered at site in total/ semi knock down conditions depending upon the conditions. The framework shall be of extruded aluminium hollow sections fitted with pre-formed insulated sections. All the members shall be assembled thru mechanical joints to make a sturdy and strong framework for various sections.

Double skin panels (each not exceeding 750mm wide) shall be made of 0.60mm pre-plasticised coated Galvanised sheet steel and 0.60mm galvanised sheet inside with minimum 43mm thick P.U. insulation of 38 Kg/Cu.M injected between the panels.

The panels shall be bolted from inside on to the framework with soft rubber gasket in between to make the joints airtight. Suitable doors with powder coated hinges and latches shall be provided for access to various panels for maintenance.

The Fan and the motor arrangement shall be mounted on to the extruded aluminium framework. The entire housing i.e. The Air Handling Unit shall be mounted on the GI Base channel framework.

Drain pan shall be constructed of 18 gauge SS sheet with 25 mm thick 38 Kg/Cu.M. nitrile foam insulation. The K-value shall not be more than 0.014 Kcal/hr-sq.mtr-°C/M at 10°C mean temperature. The pan shall have the necessary slope to facilitate fast removal of condensate. The coil shall be mounted on the rollers in order to facilitate easy removal of the coil from the drain pan for cleaning. Outlet shall be provided on both sides of the drain pan.

4.2 MIXING BOX

AHU's requiring mixing boxes for re-circulatory units shall be complete with fresh and return air dampers.

4.3 DAMPER

Dampers shall be opposed to blade type. Blades shall be made of double skinned aerofoil aluminium sections with integral gasket and assembled within a rigid extruded aluminium alloy frame. All linkages and supporting spindles shall be made of aluminium or nylon, turning in Teflon bushes. Manual dampers shall be provided with a Bakelite knob for locking the damper blades in position.

Linkages shall be extended wherever specified for motorised operation. Damper frames shall be sectionalised to minimise blade warping. Air leakage through dampers when in the closed position shall not exceed 1.5% of the maximum design air volume flow rate at the maximum design air total pressure.

4.4 MOTOR AND DRIVE

Fan motors shall be energy efficient (IE-3) and shall be 415±10% volts, 50 cycles, three phase, totally enclosed fan-cooled class F, with IP-55 protection. Motors shall be especially designed for quiet operation and motor speed shall not exceed 1440 rpm. Drive to fan shall be provided through belt-drive arrangement. Belts shall be of the oil-resistant type.

4.5 FAN

Fans shall be centrifugal type. Fans driven by variable frequency drive shall be backward inclined irrespective of static pressure value. Fan casing shall be made of galvanised steel sheet. Fan wheels shall be made of galvanised steel. Fan shaft shall be grounded C40 carbon steel and supported in self-aligning Plummer block operating less than 75% of first critical speed, grease lubricated bearings. Fan wheels and pulleys shall be individually tested and precision balanced dynamically. Fan motor assembly shall be statically and dynamically balanced to G6.3 grade as per relevant ISO/AMCA standard. Computerized fan selection print outs shall be submitted along with the offer.

Motors shall be mounted inside the AHU casing on slide rails for easy belt tensioning, and be totally enclosed,EFF1 fan cooled, to be class `F' insulation. Motors shall drive heavy duty V-belt, constant pitch, drive selected at 110% of motor horsepower. Both fan and motors

assemblies shall be mounted on a deep section aluminium alloy or galvanized steel (depending on size) base frame.

Combination spring and rubber anti vibration mounts shall be provided for isolating the unit casing. Frame retardant, waterproof silicone rubber impregnated flexible connection shall be provided at the fan discharge.

4.6 COOLING & HEATING COILS

Chilled & Hot water coils shall have 12.5mm (1/2") to 15mm (5/8") dia. tubes minimum 0.5 mm thick with aluminium fins firmly bonded to copper tubes assembled in a zinc coated steel frame. Face and surface areas shall be such as to ensure rated capacity from each unit and such that the air velocity across each coil shall not exceed 150 meters per minute. The coil shall be pitched in the unit casing for proper drainage. Each coil shall be factory tested at 21 Kg./Sq.cm air pressure under water. Tube shall be hydraulically/mechanically expanded for minimum thermal contact resistance with fins. Fins spacing shall be 11 to 13 fins per inch (4 to 5 fins per centimetre). The cooling coils shall be ARI certified

4.7 FILTER SECTION

Each unit shall be provided with a factory assembled filter section containing washable synthetic type air filters having anodised aluminium frame. The filter shall have minimum 90% efficiency down to 10 microns. The media shall be supported with HDPE mesh on one side and aluminium mesh on other side. Filter banks shall be easily accessible and designed for easy withdrawal and renewal of filter cells. Filter framework shall be fully sealed and constructed from aluminium alloy. Wherever required, separate sections for Fine Filters shall be provided in the AHU.

4.8 VIBRATION ISOLATORS

Vibration isolators shall be provided with all air handling units. The fan and motor framework shall be isolated from the AHU framework by means of spring type vibration isolators. The AHU shall be mounted on PCC blocks/frames suitable for the weight of the AHU. The framework of the AHU and the PCC blocks/frame shall be isolated by means of neoprene mats of size 150mmx150mm in two layers with 20g G.S.S. sheet sandwiched in between.

4.9 ACCESSORIES

Each air handling unit shall be complete with the accessories including but not restricted to the following.

- Insulated isolation valves, Y-strainer, header drain valves, unions and insulated condensate drain piping upto sump or floor drain in air handling unit room / nearest point.
- Manual air vents at high points in the cooling coil and drain plug in the bottom of the coil.
- Thermometers in thermometer wells and pressure gauges in test points in chilled water supply and return lines.

ELECTRONICALLY COMMUTATED MOTOR BASED FAN COIL UNITS

1.Scope:

Section Includes: Fan coil units complete in accordance with the requirements of the Contract Documents.
Works includes but is not limited to the following:
Energy efficient; low noise (> NC 35 or lesser) version of following fan coil units: Ceiling concealed / Ducted / Wall / ceiling / floor standing decorative type, Cassette Type Fan Coils.
Water temp 7/12 deg C and for hot water 50/45 deg C

2.Material:

General: Fan coil realised with support structure in galvanised steel. It should have holes in the rear part of the appliance for wall mounting and should have a condensate drip tray with non corrosive material. For the models without cabinets, the closing panel of the ventilation unit is mounted on the front. The feet (accessory) for the ducted units are made of galvanised steel sheet metal.
PROTECTIVE CABINET When FCU placed open in the room - Casing colour RAL9003 / Flow grids colour RAL7047 or as per the architecture layout approval. The casing should be made with galvanised steel sheet metal and painted with polyester powder to guarantee high resistance to rust and corrosion.
The feet (accessory) for the units with casing are made of plastic colour RAL9003.

3.Fan Unit:

Fan unit: Centrifugal Inverter motor fans with double wing suction blades developed in length to achieve high flow rates at low revs. The motor make should be as per manufacturer recommendation provided the type of motor should full fill the tender specifications.
Electric motor protected against overloads with a start condenser always inserted, directly coupled to the fans and buffered using elastic mounts. Extractable and inspecting screw in low-noise plastic material. The fan-motor should handle a minimum 8 mm ESP, if required.

4.Filter Section:

Removable filter made from regenerable materials and which can be washed.
Filtration class G4

5.Coil type:

Fan-coil should be supplied with a single three-rows (standard) or four/six-rows (enhanced) coil, with copper tubes and aluminum fins wherever required in BOQ; the manifolds should fit with female plugs and air vent should be located at the top. The connections should position on the left side of the coil but should be reversible during installation.

6.Condensate drip tray:

There should be two condensate drip trays: one for vertical installation and one for horizontal installation. Both basins are thermally insulated and have double drainage to the right and to the left. The unused drain must be sealed as per the site adjustment.

7.Coil Thickness should vary or equal to (> 8mm - 9.8mm <)

8. Control:

The control panel should be in the fan coil head and may be protected from tampering by locking the cover door with a screw. In units with the T-Touch electronic controller and the App application, by simply placing the smart device on the fan coil it should be possible to set operating modes and weekly hour programming using the APP's graphic interface. It should also be possible to access a wealth of additional information such as the alarms list, the closest Technical Service Centre etc.
Available for Android OS.
In versions where the control panel is an accessory, it can be installed on the fan coil or be wall-mounted. In wall-ceiling mounted versions the control panel (accessory) can only be installed on the wall.
The fan coils should have the option to integrate with BMS if asked in the BOQ.

9. Manufacturer:

The products or manufacturers listed herein are included for the purpose of establishing minimum quality standards. Products equal in quality or better than those specified will be considered if they are produced by a specialized manufacturer whose units are equal in every respect and have been in similar service for not less than thirty (30) years.

A. Submit coil pressure drop, manufacturer's specifications for fan coil units showing dimensions, capacities, ratings, performance characteristics include sound power level, gauges and finishes of materials and installation instructions. Need to submit software selection with all details.

B. Shop Drawings: Submit assembly-type shop drawings showing unit dimensions, constructions details and field connection details. Shop drawings shall show coordination with all related work sections.

C. Wiring Diagrams: Submit manufacturer's electrical requirements for power supply wiring to Fan Coil units. Submit manufacturer's ladder-type wiring diagrams for interlock and control wiring. Clearly differentiate between portions of wiring that are factory-installed and portions to be field-installed.

6.0 CHILLED WATER PIPING

6.1 Following material shall be used for pipes and fittings.

Pipes Nominal size (mm)	**Material Specification**
≤150	IS 1239 Part-1 (Mild steel medium class (Black steel) tube)
200 and above	IS 3589 Gr. FE 48 (6mm thick ≤300NB, 8mmthick > 300NB &≤ 600NB, 10mm thick above 600 NB) (welded black steel pipe, class 2)

Fittings Nominal size (mm)	**Material Specification**
≤40	Socket welded, ASTM A85 as per ANSI B16.9
50-150	Butt welded, ASTM A234 Gr. WPB as per ANSI B16.9
≥200	Site fabricated from IS 3589 Gr. FE 48 (6mm)

Flanges Nominal size (mm)	**Material Specification**
≤ 150	ASTM A85 as per ANSI B16.5 (#150 class)
≥200	IS 2062 Gr.A, as per ANSI B16.5 (#150 class)

All jointing in the pipe system shall generally be by welding, unless otherwise mentioned, or directed at site. All welding shall be done by qualified welders and shall strictly conform to BIS Code of practice for manual metal arc, welding of Mild Steel.

Spacing of pipe supports shall not exceed the following:

Pipe size	Spacing between supports	Rod Size
Upto 12 mm	1.5 Meter	8 mm
15 to 25 mm	2.0 meter	8 mm
30 to 150 mm	2.0 meter	8 mm
Over 150 mm	2.5 meter	12.5 mm

6.2 All welded joints (except pipe welded end-to-end) shall be made by use of one-piece welding flanges, caps, nozzles, elbows, branch outlets and tees of approved make. Cut samples shall be submitted for approval, if directed. All such fittings etc., shall be of a type which maintain full wall-thickness at all points, simple radius and fillets, and proper bevels or shoulders at ends. All job welding shall be done by the electric arc welding process in accordance with the following:

- All joints shall have 45 degree bevel type, pipe mill-bevelled or machine-bevelled by the contractor.
- All scale and oxide shall be removed with hammer, chisel or file and bevel left smooth and clean.

6.3 All pipes and their steel supports shall be thoroughly cleaned and given one primary coat of red oxide paint before being installed. For vibration isolators remoulded polyurethane pipe sections of 160 Kg/m3 density with adhesive shall be fixed between pipe and MS support. 8 mm thick MS 'U' clamp with resistoflex shall be fixed on the pipe so that the pipe is kept in position.

6.4 Ball and butterfly valves conforming to the following specifications shall be provided as shown on Drawings:

Size	Construction	Ends	Type
15 to 40 mm	Brass ASTM B62	Screwed	Ball
50 mm and over	Body Cast iron,	Wafer	Butterfly

Valves shall have non-rising spindles unless specified otherwise and shall be suitable for PN 10/ PN 16 rating.

6.5 BUTTERFLY VALVES

Butterfly valves shall perform the function of isolating valves. Butterfly valves shall have a cast iron body with black nitrile rubber seat and shall be suitable for PN 10/ PN 16 rating as indicated in the schedule of quantities. All butterfly valves shall be provided with locking devices. Valves 250 mm and above dia shall be gear driven.
Butterfly/Ball valves shall be provided at

i. Suction and delivery side of pumps.
ii. Inlet and outlet of each condenser, chiller & cooling towers.
iii. Inlet and outlet of AHU, FCU, TFA etc.
iv. All drain connection from equipments

6.6 BALANCING VALVES

Manual double regulating balancing valves shall be provided at chiller, condenser, various tap-offs and each AHU outlet line.

The valves shall have built-in pressure-drop measuring facility to compute flow rate across the valve. The test cocks shall be long enough to protrude out of pipe insulation.

6.7 All ball valves and ball valves with Y strainer shall be bronze forged body construction with chrome plated bronze ball and handle of stainless steel constructions.

6.8 NON RETURN VALVES

Non return valves shall be dual plate check valve conforming to relevant Codes and in accordance with the following Specifications:

Size	Construction	Ends
50 to 150 mm	Body cast iron, gun metal plate.	Flanged
200 mm to 450 mm	Body cast iron, plate carbon steel with 11% chrome overlay.	Flanged

The spring and hinge/stop pin shall be SS304 and bearing PTFE material. Valves shall be PN 10/PN 16 rating.

6.9 Y-STRAINER

The Y-strainer shall be fabricated out of MS `C' class pipe two size higher than that of strainer pipe size. Flanges as per BS 10 shall be provided at inlet & outlet of connections. The body shall be pressure tested at 10 Kg/Sq. cm and shall be hot dip galvanized.

Permanent magnet shall be provided in the body of the strainer to arrest MS particles. Filter element shall be of nonmagnetic 20 gauge SS sheet with 3 mm perforation. Strainer shall be provided at the inlet of each AHU & chilled water pumps. It should be easily removable when required to be cleaned. Isolating butterfly valves at either end of the strainer shall be provided.

6.10 **Flanges** shall be of PN 10/PN 16 rating. Flanges shall be provided with bolts, washers, nuts and suitable rubber insertion gaskets (minimum 5 mm thick)

6.11 All piping work shall be carried out in a workmen like manner, causing no or minimum disturbance to the existing services, buildings and structure.

7.0 SHEET METAL DUCT WORK

7.1 All supply and exhaust duct work for BSL-3 Laboratory within within the containment barrier (i.e. from HEPA filter to room on supply side and from room to HEPA Filter on exhaust side) shall be done in SS304. The duct work shall be as per SMACNA standards.

7.2 The thickness of sheet for SS ducting shall be as per IS 655 (For medium and high pressure duct)

7.3 All SS 304 duct work shall be in welded construction and shall be factory tested at +1000 Pa and soap bubble tested to ensure no air leakage before commissioning of BSL-3 laboratory.

7.4 Duct work in other areas shall be constructed out of best quality cold annealed, flat galvanized sheet steel (galvanized to specifications of IS : 277 (latest edition). The grade of coat for GS sheet shall be 120 gm / sq m (table 2 of IS 277-1992).

The joints shall be finished straight and neat. The duct work shall be supported / secured from roof slab or any other building member using angles, rods as may be required.

Thickness of sheets shall be as shown in the tables given below:

Maximum size of Rectangular Duct (in m)	**Round Duct dia (mm)**	**Thickness of Sheet in mm**
Upto 750	Upto 600	0.63 (24 G)
751 to 1500	601 to 750	0.80 (22 G)
1501 to 2250	750 to 900	1.00 (20G)
2251 & above	901 & above	1.25 (18 G)

The fabrication of duct shall be done as per IS : 655 (latest edition). Transverse joints, connections, bracing, seam etc. shall be as per IS : 655.All the ducts over 300 mm in either dimension shall be cross broken except those on which rigid board insulation is applied. Stiffening angles shall be black structural steel and riveted to the duct work. The longitudinal seam on all ducts may be Pittsburgh seam hooked and hammered. Ducts of size 600 mm and above shall be reinforced between the joints. Where drive-slips are used, angles shall be riveted to the ducts 50mm from slips.

7.2 Simple elbows, transformation sections shall be formed with Pittsburg corner seams. Complicated fittings shall be constructed with double corners. Elbows, bends and offset pieces shall have a center line radius of not less than 1.5 times the radial of width of the duct. Turning vanes should be provided at required spacing such that the aspect ratio of each individual elbow formed by vanes shall not be more.

7.3 Dampers shall be provided in the duct work for proper control and balancing of air distribution. Dampers shall have an easily accessible operating mechanism. The operating mechanism shall consist of links, levers and quadrants as required for proper control and setting in a desired position. The position of the handle of Damper operating mechanism shall be clearly visible and it shall indicate the position of the damper in duct. Dampers, splitters and their operating mechanism shall be fabricated of GS sheets of two gauges heavier than duct piece having these fittings and shall be easily accessible through suitable access doors in the ducts.

7.4 FIRE DAMPERS

The fire dampers shall be fabricated out of 1.6 mm galvanized sheet steel and shall be a multi leaf type. The damper blades shall be provided on both ends using chrome plated spindles in

self-lubricating bushes. The damper shall have spring type motorized actuators, control panels and temperature sensors. Stop seals shall be provided on top and bottom of the damper housing made of 16G GSS. For preventing smoke leakage side seals shall be provided. The fire dampers of at least one and a half hour rating.

7.5 DIFFUSERS & GRILLES

All sidewall supply grills shall be double deflection type with both horizontal and vertical vanes being adjustable. Grilles shall be provided with multi-louver damper for volume control with adjustable handle. Sidewall grille shall be similar to Tuttle & Bailey. All return air and exhaust grilles shall have only horizontal louvers. The supply air grills and return air grills shall be on same face and continuous. Supply air ceiling diffuser shall be provided with volume control dampers which can be operated from below.

All the diffusers and grilles shall be of powder coated aluminum. Diffusers and grilles shall be provided with a sponge rubber gasket between flanges and wall or ceiling. The shade of Grills and Diffuser shall match the Building finish and get approved by Engineer-in-charge.

7.6 BUBBLE TIGHT ISOLATION DAMPERS

The damper construction shall meet the following specifications:

a)	Construction	- SS 304
b)	Frame	- Flanged, round/square (as per duct)
c)	Blade	- SS 304, round
d)	Blade seal	- Silicone
e)	Axle seal	- Double gland seal
f)	Bearings	- Ball bearings

The damper performance shall meet the following specifications:

a)	Maximum pressure	- 10” wg
b)	Maximum velocity	- 3900 fpm
c)	Maximum leakage	- Zero at 10” wg

Each damper shall be equipped with a compatible motorized actuator.

Each Isolation Damper shall be factory tested for leakage in accordance with AMCA 500-D, before supply to ensure bubble-tight performance.

7.7 VARIABLE AIR VOLUME DEVICE

The supply and exhaust in BSL-3 Laboratory shall be controlled and provided with VAV devices with integral airflow measuring devices for precise control of room supply and exhaust air quantities.

The Variable Air Volume Device complete with airflow control valve with integral airflow measuring device shall conform to the following specifications:

General Operation : The VAV shall operate on pneumatic control air distributed through a manifold to each of the airfoils to expand and contract them. This expansion or contraction of the vanes shall modulate the airflow in the duct by increasing and decreasing the open area of the valve.

The modulation shall be linear over a 20 to 1 range. The pneumatic control air that is fed to the manifold shall be regulated by a DC Voltage transducer (2-10 VDC) which shall be provided with the unit as standard feature. The pneumatic control air requirement shall be at approx. 20 psi. The valve shall provide for high air flow volumes at low pressure.

The airflow measurement device shall consist of a multi-sensor probe and transmitter. The device shall provide reliable and accurate measurement of airflow. The number of probes and sensors shall be as per manufacturer recommendations. The probes shall provide pulse type electronic output signals linear to the air flow. The transmitter shall provide 2-10 Volt DC output. The probes shall be pre-connected to the transmitter. An integral calibration standard shall be provided in the transmitter to allow for the calibration of the unit in the field.

Construction : The valve body and pneumatically controlled airfoils shall be fabricated in stainless steel. The inlet and outlet of the valve shall be round in construction unless a rectangular section has been specifically asked for. The valves shall have at least 2" inlet and outlet extensions to allow 'slip fit' into the ductwork.

The probe sensor shall be in SS 304. The transmitter shall be in NEMA 1 enclosure. The probes shall be impervious to dirt and other suspended materials in the air stream.

Other Specifications/features :

Temperature limits	-	-20 to 140 DegF
Humidity	-	0 to 100% RH
Pneumatic air requirement for transducers	-	20 psi (clean and dry air)
Maximum pressure	-	25 psi
Maximum shutoff leakage at 4" WG inlet pressure	-	3% of rated airflow
Flow sensor accuracy	-	+/- 1.5 %

8.0 FILTERS

8.1 PRE-FILTERS

Air flow	As required for specific system
Frame	Aluminium anodised, cassette type made of 2.00 mm thick sheet
Medium	Polypropylene non-woven supported by anodised aluminium mesh on one side HDP mesh on other side, 11 folds per feet of face area
Sealing of media	By means of ductile epoxy resin
Efficiency	90 % down to 10 micron particle size (minimum)
I.P.D.	<3mm wg at rated cfm
F.P.D.	6 mm wg (maximum)
Thickness	50mm
Filter face velocity	500FPM (maximum)

8.2 MICRO VEE (FINE FILTER)

AIR FLOW	As required for specific system
FRAME	Aluminium anodised, flanged type made of 2 mm sheet
Medium	Polypropylene non woven supported by anodised aluminium mesh on one side HDP mesh on other side 11 folds per feet of face area
Sealing of media	By means of ductile epoxy resin

Efficiency	99.9 % down to 5 micron particle size (minimum)
I.P.D.	<8mm wg at rated cfm
F.P.D.	15 mm wg
Thickness	305mm or as specified in schedule of quantities
Filter face velocity	500 FPM (maximum) for 305 mm thick
Gaskets	Rubber gasket on flange.
Packing	Each filter shall be packed in a polythene bag and then placed in carton box.

8.3 HEPA FILTER (ABSOLUTE)

AIR FLOW	As required for specific system
FRAME	Aluminium anodised, flanged type made of 18G sheet
Medium	Micro Fibre glass paper, Borosilicate.
Sealing of media	By means of ductile epoxy resin
Efficiency	99.97 % down to 0.3 micron particle size (minimum)
I.P.D.	<15mm wg at rated cfm
F.P.D.	40 mm wg
Separators	Corrugated aluminium
Thickness	305 mm or as specified in schedule of quantities
Filter face velocity	500 FPM (maximum) for 305 mm thickness
Gaskets	Rubber gasket, 6 mm thick to be fixed on flange and sealed on internal edges with epoxy resin.
Packing	Each filter shall be packed in a polythene bag with either face protected by flat hard board/ ply. Assembly to be packed in strong cardboard cartons printed with handling and opening instructions.

8.4 HEPA FILTER CONTAINMENT HOUSING

The HEPA Filter Containment Housing shall be made in SS 304 (14 gauge) with air tight and leak proof construction. All joints shall be seamlessly welded, buffed and polished. The HEPA Containment Housing shall have provision to carry out on site HEPA filter scanning, testing and validation, magnehelic gauge to monitor pressure drop across the HEPA filter, fumigation ports to allow IN-SITU decontamination of HEPA filters and Bag-In-Bag-Out facility for filter change.

Each containment housing shall have the following features:

1. **Differential Pressure Ports** – Differential pressure ports along with Magnehelic Gauge to monitor the pressure across upstream and downstream of HEPA filter
2. **Aerosol Injection Port** – Port for injecting aerosol at upstream side and downstream side of HEPA filter
3. **Manual Scanning** – A scanning facility towards HEPA Filter downstream side for manual scanning and testing of filter
4. **BagIn-Bag Out** – Bag in-Bag Out facility for filter replacement
5. **Isolation dampers** – Bubble tight Isolation dampers at Containment Housing inlet and outlet, leak tested to ensure a 'bubble tight' seal at a differential pressure of 10 inches water gauge.
6. Components like doors, filter locking and seal arrangements shall be in SS 304.

Each Containment Housing shall be factory assembled and shall be tested in accordance with ANSI/ANSE-N510-1995 at +/- 10" wg.

9.0 CENTRIFUGAL FANS

9.1 Fans, Aerofoil, forward or backward curved, SISW or DIDW, shall be licensed to bear the AMCA Air and Sound Certified Ratings Seal. The test standard used shall be ANSI/AMCA 210-85, ANSI/ASHRAE Standard 51-1985 "Laboratory Method of Testing Fans for Rating" and AMCA 300 "Reverberant Room Method for Sound Testing of fans".

9.2 All fans shall be dynamically trim-balanced to ISO1940 and AMCA 204/3 - G2.5 quality grade after assembly. A computer printout with vibration spectrum analysis shall be attached to the fans.

9.3 Fan should be of G.S.S. , the Steel sheet should be JFE Galva zinc (Base metal cold rolled), JIS G3302, SGCC with Z22 (minimum coating weight on both sides @ 220 g/m2) zinc coating & Zero Spangle, skin passed, chromated and dry.

9.4 Fans housing shall be of an appropriate thickness to prevent vibration and drumming. The fan scroll shall be attached to the side plate by means of continuous lock seam or intermittent spot welding. The wheel and inlet cone shall be aerodynamically designed and constructed to provide maximum performance and efficiency as published by the manufacturer.

9.5 Fans must be physically capable of operating safely at every point of rating at or below the "minimum performance" limit for that class as defined in AMCA standard 99-2408-69 "Performance Class of Operating Limits for Centrifugal Fans".

9.6 Shafts sizes shall be carefully calculated and designed such that the maximum operating speed (RPM) shall not exceed 75% of the first critical speed. For any application that is not a standard product from catalogue of the fan manufacturer detailed calculation of critical speed characteristic shall be submitted for approval.

9.7 Shafts shall be made of carbon steel (C45) machined and polished to tolerance of standard ISO 286-2 - grade g6. Protective coat of anti-rusting shall be applied to all bare surfaces of the shafts at the factory.

9.8 Bearings shall be of self-alignment (concentric) type with adaptor sleeve bearing. Bearings of eccentric locking collar with grub screw type are not acceptable. Bearing shall be maintenance free with permanently lubricated sealed ball bearing type. Bearing life shall be at least 75,000 hours based on basic rating life, L10 of ISO 281 standard. Calculation sheet of Bearing Life shall be submitted for approval.

9.9 Motor installed shall be of a minimum 130% of the fan power absorbed (Brake horsepower) and shall have sufficient torque available for starting and continuous operation.

9.10 Belts and pulleys shall be sized for a minimum 150% of the installed motor horsepower. The belt speed shall not exceed 30m/s. The pulley shall be of Taper Lock SPZ, SPA, SPB or SPC type. Conventional type of pulley is not acceptable. Both fan and motor pulley shall be balanced to the quality grade G.2.5.

9.11 Fan outlet velocity shall not exceed 10% of the main duct air velocity designed (0.1" per 100 ft or 1 Pascal per meter duct length). Pressure Loss is as referred to in SMACNA Standard, unless otherwise specified.

10.0 INSULATION

10.1 Thermal insulation material for Duct & Pipe insulation shall be closed cell Aluminiumfaced Elastomeric Nitrile Rubber. The duct insulation shall have self-adhesive backing with a peal-off cover for easy installation at site. Thermal conductivity of the insulation material shall not exceed 0.038 W/moK or 0.212 BTU / (Hr-ft^2-ºF/inch) at an average temperature of 30ºC. Density of the nitrile rubber shall be 40-60 Kg/m^3. The product shall have temperature range of –40 ºC to 105ºC. The insulation material shallbe fire rated for Class 0 as per BS 476 Part 6 : 1989 for fire propagation test and for Class 1 as per BS 476 Part 7, 1987 for surface spread of flame test. Water vapour permeability shall be not less than 0.024 per inch (2.48 x 10-14 Kg/m.s.Pa i.e. μ>7000: Water vapour diffusion resistance).

10.2 The insulation thickness for duct work shall be as follows:

a) Supply Air duct - 19 mm
b) Return/exhaust Air duct - 13 mm

10.3 Chilled water and Hot water piping shall be insulated in the manner specified herein. Before applying insulation, all pipe work and fittings shall be brushed and cleaned, and dust, dirt, mortar and oil removed.

All pipes shall be provided with a coat of zinc chromate primer, followed by two coats of cold setting adhesive compound. Thermal insulation shall then be applied as follows:

Pipe size (mm)	**Thickness for expanded Polystyrene (TFQuality)mm(24 Kg/m3)**
10 to 40	25
50 to 150	50
Above 150	75

Premoulded pipe sections shall be placed over the pipes, the longitudinal and transversal joints of these pipe sections shall be sealed with the adhesive compound. The insulation shall be continuous over the entire run of piping, fittings and valves.

Insulation shall be applied only after the piping system has been satisfactorily tested for leaks at 1.5 times the working pressure or at minimum 10 kg/sq.cm. test pressure. All insulated pipes shall be covered with two layers of 400 gage polythene sheet to act as vapour barrier. PVC straps at 400 mm centre shall be used to hold insulation and vapour barrier together. Insulation shall be covered with 26 gaugealuminium sheet cladding and finished in neat and clean manner so as to achieve true surface. All longitudinal and transverse joints in the outer cladding shall have a minimum overlap of 50 mm duly beaded and grooved and shall be sealed.

11.0 CONTROLS

11.1 3-WAY MIXING VALVE

For Air Handling Units, 3-way mixing valves shall be provided in chilled water and hot water line at each unit. Each valve shall be actuated by a space thermostat. Constant space conditions shall be maintained by allowing all of the chilled water to either pass

through the coil or to bypass the coil and mix-with the chilled water return. The valve shall revert to fully bypass position when fan is shut off. Valve shall have brass seat, self adjusting Teflon cone packing and constant total flow through full plug travel. The valve shall have min. travel time between fully open and closed position.

11.2 Thermostats

Shall be electronic type with 3 point output for modulating 2 position reversible motor of 3-valve of AHUwith sensing element located in the return air stream. The profile, mounting arrangements and exact location of the thermostats shall be as approved by the Engineer in charge. All thermostats shall be supplied with the standard mounting boxes, as recommended by the manufacturer.

11.3 **Thermometers** shall be mercury-in-glass type with cast brass scale in a steel casing. Thermometers shall be filled with red reading mercury. Thermometers shall be of the separable socket type and shall have extended neck, where required, for insulated pipes. The scale shall be 23 cm long. Thermometers shall be installed at chilled water and hot water supply and return at air handling units, supply and return at chillers and condensers. Range of scales shall be 30-120 F (0-50) for air conditioning applications.

11.4 **Pressure Gages** shall be installed on suction and discharge sides of pumps, chilled water and hot water supply and return at air handling units, inlet and outlet at chillers, and condensers. Suction side gauges at pumps shall be compound gauges of 150 mm dia.

12.0 BUILDING MANAGEMENT SYSTEM

12.1 A customized Building Management System shall be provided to operate and monitor the laboratory operating parameters, critical equipments and HVAC system in the BSL-3 Laboratory, BSL-2 Laboratory and Animal Facility.

12.2 The function of the BMS shall be, but not limited to, as given hereunder:

- Room/Area/zone pressure in BSL-3, BSL-2 and Animal Facility
- Room/Area/zone temperature & RH in BSL-3, BSL-2 and Animal Facility
- Ambient temperature & RH
- AHU and Exhaust Blower operating status of BSL-3, BSL-2 and Animal Facility
- Modulate VFD's and monitor VFD status
- Modulate VAV's and monitor VAV status
- Pressure Drop across across each HEPA Filter
- OPEN/Close dampers operation and status at AHU Inlet
- Supply & exhaust air quantity in each BSL-3 Laboratory rooms/zone.
- Chilled Water Supply and ReturnTemperature at each chilling unit
- Chiller operating status and monitoring
- Complete HVAC System Operation and Shutdown in Auto Mode through BMS
- BSL-3 Lab Isolation damper operation and status
- Archiving of Autoclave decontamination cycle data
- Archiving of BLED plant decontamination cycle data
- Operation and status monitoring of each IVC
- Allow to sequence each chilling unit through BMS to maintain equal run time
- Enable and disable each chiller unit through BMS

12.3 The major components of BMS system shall include:

- Operator and engineering workstation comprising of latest configuration desktop PC with all required hardware and software
- Field devices (sensoros, transmitters etc.)
- Power and control cabling
- PLC based BMS control panel complete with controllers as per requirement
- VAV devices for BSL-3 Laboratory supplay air and exhaust air
- VFD for AHU motors and Exhaust blower motors of BSL-3 Laboratory, BSL-2 Laboratory and Animal Facility
- Cutomized software
- HMI Touchscreen panel at BSL-3 Lab entry
- Desktop PC with color monitor and printer
- Any other component to complete the BMS work

12.4 The Building Management System shall allow START/STOP operation of the Complete HVAC system in AUTO Mode. The system shall also have the provision to over-ride the parameters (password protected).

12.5 The BMS shall generate alarm in case of HVAC system failure, collapse in room/zone pressure and/or disruption in other operating parameters from the set limits.

12.6 The HVAC system START and STOP sequence shall be interlocked to prevent reverse pressurization of the BSL-3, BSL-2 & Animal laboratory, at any point of time

12.7 The BMS control panel shall be powered through UPS. Upon restoration of power after a power failure, the BMS shall start the HVAC system automatically without any human interface and restore the normal operational set points of the system.

12.8 The BMS graphics shall have the ability to display real time field data and change colour of symbols based on field conditions. For example a fan could be green when 'ON', white when 'OFF', red when 'IN-ALARM' conditions

12.9 All components and controllers shall be true "peer-to-peer" communicating devices. Components or controllers requiring "polling" by a host to pass data shall not be acceptable

12.10 The Contractor shall submit complete BMS architecture with list of I/O's and BMS system configuration for approval before proceeding with the BMS work.

13.0 TESTS AFTER INSTALLATION

13.1 SAFETY AND CONTROLS

a) Interlocks for compressor motor with chilled water pumps shall be checked.
b) Operation of Flow switch in chilled water lines shall be checked.
c) High pressure-stat shall be checked
d) Low pressure stat shall be tested
e) Anti-freeze thermostat shall be tested
f) Oil failure switch shall be tested

13.2 After Air balancing, the quantity of air through every outlet and room performance parameters for pressure and temperature shall be tested

13.3 Capacity Test of Chiller, Air Handling Units, Exhaust Blowers etc.

13.4 BMS function and operation of system through BMS

13.5 Any other test / check decided and directed by Engineer to acertain the correctness of installation and verify the performance and capacity of equipment/system.

SECTION - IV

TECHNICAL SPECIFICATIONS FOR LABORATORY EQUIPMENTS AND SYSTEMS

TECHNICAL SPECIFICATIONS - EQUIPMENTS AND SYSTEMS

1.0 PASS BOX

1.1 DYNAMIC PASS BOX

1.1.1 The Pass Box shall be constructed in SS 304 (18 gauge). The corners inside the Pass Box chamber shall be coved for easy cleaning. The pass box chamber dimension shall be approximately 610 mm x 610 mm x 610 mm or as required. The unit shall be complete with HEPA filters, blower, motor, door electromagnets, door interlock, UV Lamp with timer and hour meter, necessary wiring, controls and all other accessories. etc. complete.

1.1.2 The Pass Box doors shall be interlocked by providing suitable electromagnet, so that both the door cannot be opened simultaneously. The interlock shall provide visual indicator for door open/close conditions.

1.1.3 The blower motor of Pass Box shall of suitable rating and shall be dynamically and statistically balanced. Magnehelic differential pressure gauge shall be provided to indicate the pass box chamber pressure.

1.1.4 The pass box shall be provided with UV light and shall be interlocked with the pass box doors. The UV Light shall be provided with timer to indicate hours of UV light usage. UV light operation shall be provided through a 24 Hr timer switch.

1.1.5 The Supply Air velocity across the terminal HEPA filter in Pass Box shall be approximately 0.45 m/sec. Noise level shall be less than 70 dB. The pass box shall be installed flushed with the wall on BSL-3 Lab side and projected on the other side. The projected side shall be provided with SS coving at the pass box and wall junction.

1.1.6 The Pass Box shall be complete with following filters :

Pre-filter : 95% efficiency down to 5 microns
Final Filter : HEPA Filter with 99.97 % efficiency down to 0.3 microns

The blower motor shall of suitable rating and shall be dynamically and statistically balanced.

1.1.7 Magnehelic differential pressure gauge shall be provided to indicate Pressure drop cross the HEPA filter

1.2.1 STATIC PASS BOX

1.2.1 The Static Pass Box shall be constructed in SS 304 (18 gauge). The corners inside the Pass Box chamber shall be coved for easy cleaning. The pass box chamber dimension shall be approximately 610 mm x 610 mm x 610 mm or as required. The pass box unit shall be complete with door electromagnets, door interlock and UV Lamp with timer and hour meter including necessary wiring and controls and all other accessories. etc. complete.

12.2 The Pass Box doors shall be interlocked by providing suitable electromagnet, so that both the door cannot be opened simultaneously. The interlock shall provide visual indicator for door open/close conditions.

2.0 DUNK TANK

Dunk tank shall be provided at approved locations in the final design. The dunk tank shall be constructed in SS 316 L (16 gauge) suitable for active use of disinfectant chemical like NaOH, Sodium Hypo-Chloride Solution. Approx size of dunk tank shall be 550x550x900 mm. The drain outlet of the dunk tank shall be provided towards the containment side.

3.0 SHOWER SYSTEM FOR BSL-3 LABORATORY AND BLED PLAN ROOM

3.1 The nude shower system for BSL-3 Labs shall comprise of pre-fabricated cubicle module for each entry/exit channel constructed in SS 304 (16 gauge) of approximately 1m x 1m size.

3.2 All the joints shall be argon welded and perfectly buffed and shall be free from any blurs and sharp edges. The shower cubicle shall be provided with supply & return air diffusers and light fixture.

3.3 The shower cubicle door shall be biosafety door in SS 304 of approximately 750x 2100 mm size and provided with inflatable gasket to provide air-tight sealing of doors suitable to sustain the pressure decay test.

3.4 The shower drain shall be seamlessly connected to the floor drain and terminated to the BLED system. The drain connections shall be tested to ensure there is no leakages.

3.5 The shower system shall include a water heater/calorifier for supply of heated water to the showers at controlled temperature (30-35 Deg. C) during winters. The shower system shall be complete with a separate shower water storage tank, insulated water distribution/recirculation piping, water distribution pumps (1W+1S), valves, flow meters, batch controllers (to set each shower cycle and shower volume), hot water generator, control panel and all other necessary controls, wiring, piping etc. complete as required.

3.6 The shower system piping shall be in AISI SS 304 grade as per JIS 3448 standards and fittings as per JWWA G116 standard.

4.0 COMPRESSED AIR SYSTEM

4.1 COMPRESSED AIR SYSTEM FOR PROCESS AIR

The system shall include providing 1 No.m oil injected rotary scre compressor, skid Mounted and air-cooled type. The air compressor shall be complete with in-built compressed air reservoir, oil and particulate removal filters, starter controls, pressure regulating valves, ball valves, compressed air distribution piping system etc. complete in all respect.

Expected Capacity (for guidance only) :

Motor	- 7.5 hp / 5.5 kw
Max. Pressure	- 10 bar
Air delivery	- 27.5 cfm
Air receiver capacity	- Approx. 270 Ltrs.
Noise level	- 65 dB (A)

4.2 The compressed air piping shall be done in heavy class GI pipes conforming to IS 1239 (latest version), fittings, isolation valves fitted at required location to permit uninterrupted maintenance and service of distribution line.

4.3 The compressed air outlet points shall be provided for supply of compressed air to pneumatic valves of Autoclave, Biological Effluent Decontamination system, inflatable gaskets of biosafety doors at all the required locations as per approved designs.

5.0 VENTILATED TYPE GARMENT STORAGE CABINET

a) The Garment Storage Cabinet shall be constructed in SS 316 L and shall be ventilated type.

b) The front panel shall be constructed with SS 316 L frame and toughened glass panel

c) The garment storage cubicle shall conform to BS 5295-76

d) The garment storage cubicle shall be complete with motor blower assembly, recirculatory plenum, heater with thermostat, fluorescent light, UV germicidal lamp with hour meter and 24 Hour timer switch for operation, Prefilter, HEPA filter, Activated carbon filter for odour neutralization, control switches, indications etc.

e) The garment storage cubicle shall meet the following operational requirements :

f) Approx. Dimensions (external) : 1000 mm (W) x 700 mm (D) x 1800 (H)
(size shall be as per site space availability)
Air Flow : Shall be 0.45 m/sec to 0.65 m/sec
Cleanliness Level : Class M 3.5
Noise Level : Less than 70 dBA
Vibration Level : Less than 2.5 microns
Power requirement : 230 V AC, 50 Hz, 1 Phase

6.0 LABORATORY WORK STATION

6.1 The BSL-3 and BSL-2 Laboratory rooms shall be provided with workstations, as per approved layout drawing. The work stations shall be provided with the most optimum utilization of space in the laboratories.

6.2 Hand wash sinks and emergency eye wash stations shall be provided in each BSL-3 and BSL-2 Laboratory room, integrated with the work station.

6.3 Taps shall be hands free type and elbow operated with swan neck.

6.4 The workstations in BSL-3 and BSL-4 Laboratories shall be constructed in SS 304 (16 gauge).

6.5 The workstations in BSL-2 Laboratory shall be modular type in powder coated mild steel construction and with granite top.

6.6 The workstation shall have under counter storage space and drawers. Each work station shall be provided with a swivelling type laboratory chair with castor wheel. The chairs in shall be in SS frame and seat (fabric and leather finish seats shall not be accepted).

7.0 BIOLOGICAL EFFLUENT DECONTAMINATION SYSTEM (STEAM SYSTEM)

7.1 Supply, installation, testing and commissioning of fully modular skid mounted biological liquid waste decontamination system, including and comprising of :

a) Cook Tanks of 1000 Ltrs Capacity – 2 Nos.
b) Integrated Effluent Transfer and Control System
c) Temperature Sensors for jacket steam solenoid valve and chamber – 3 Nos.
d) Safety Valves, Rupture Disc, Vent Valve etc.
e) Vapor Handling Skid for Vent Valve
f) Effluent Discharge Line from Cook Tanks
g) PLC Based Control Panel
h) Pumps for effluent transfer from sump-2 Nos.

7.2 The cook tanks shall have chamber capacity of 1000 Ltrs, in which the decontamination cycle will start once the level of collected liquid effluent reaches ~800 Ltrs. The tank will be in heavy gauge SS 316 L. The vessel will be in horizontal/vertical design with external insulation in mineral/rock wool duly cladded in aluminum finish for both tanks as well as the piping. The system shall include interconnected piping to integrate with the cook tanks, a mild steel access platform/staircase for access and maintenance.

7.3 Integrated effluent transfer and control system shall include:

7.3.1 Automated liquid effluent release and bypass system into the cook tanks trough SS 316 automated ball valve which will be closed once the effluent level reaches ~800 Ltrs. and the level sensor signal is activated. Automatically the ball valve of the second cook tank will be opened for allowing the laboratory effluent to start flowing into the empty tank.

7.3.2 Level sensor system in all the cook tanks to sense the liquid effluent on its reaching ~800 Ltrs.

7.3.3 Set of at least 3 PT 100 temperature sensors in each cook tank - 1 for control of the jacket steam solenoid valve and other 2 in the chamber to monitor the temperature at two different levels of the liquid effluent

7.3.4 The steam, supply and discharge from the jacket will be fitted with accessories such as steam traps, non-return valve, safety valve, solenoid actuated valve etc.

7.3.5 The chamber of each cook tank shall be fitted with safety valve/s, rupture disc (both enclosed in a separate chamber) such that the vent liquid discharge is sent back to the supply piping through the adjacent cook tank and the vapor generated along with the main vapor from within the chamber generated during the decontamination cycle shall be piped to a common independent vapor handling mini-skid located above the cook tanks, fitted with absolute hydrophobic HEPA filters for safe exhaust of gaseous vent to the ambient. The filter skid shall be provided with provision for in-situ filter decontamination of filter before removal.

7.3.6 The system shall comprise of independent filtration systems for operating vent from each cook tank and a dual relief vent system - all fitted up for safe change using filter decontamination techniques.

7.4 The common discharge line from all the cook tanks shall be fitted with an after cooler to blend the release of the effluent after decontamination cycle with raw water for cooling before being discharged into the sump.

7.5 The entire system shall be controlled from an independent control panel The control panel shall be complete with touch screen panel (Mitsubishi-Beijers/Siemens/Allen Bradley), fully programmed and wired, with full decontamination cycle function recording capability. One printer shall be provided with the control panel to take decontamination batch cycle printouts.

7.6 The Decontamination Cycle operating temperature shall be minimum 121° C with programmable cycle duration through the PLC

7.7 The steam supply to the BLED plant shall be from a dedicated Non IBR Steam Boiler to be supplied along with BLED Plant. The required steam piping shall be complete with pressure reducing station, distribution piping with insulation, necessary valves and accessories as required.

7.8 The BLED System validation test shall demonstrate complete kill of approved biological indicator at the maximum design capacity. Biological indicator shall be Bacillus

stearothermophilus spores using vials or spore strips, with at least $1X10^6$ spores per millilitre. Atleast 2 Nos. Biological indicator test port shall be provided complying with biosafety requirements without any breach of containment.

8.0 AUTOCLAVE

The autoclave shall be rectangular, steam operated, high pressure high vacuum, double door & single door (requirement as per approved design) suitable for horizontal loading and unloading of materials/waste, with automated sliding doors, with Bio-Seal suitable for installation and use in BSL-3 Laboratory and Animal Facility.

The autoclave shall be free standing type, the chamber drain shall be located on the containment side and connected to the Effluent Decontamination system.

Tentative Required Qty and Size (only for guidance). Actual quantity to be supplied shall be as per approved design:

Double Door Type	Approx. Chamber Size 900x900x1000mm (BSL-3 Lab)	- 2 Nos.
Double Door Type	Approx. Chamber Size 1000 x 1000 x 1200 mm (Animal Lab)	- 1 No.

CONSTRUCTION

i) The chamber shall be constructed of heavy duty SS of 316 with full argon welding . The chamber material and construction shall meet ASME standards for unfired vessels. The chamber shall be duly reinforced with carbon steel.

ii) Doors and jacket shall be constructed of stainless steel sheet of 304 grade. Doors must be provided with automatic safety locking and unlocking devices. All doors gaskets shall provide high temperature seal.

iii) Chamber and doors shall be designed for working under positive pressures upto 31 psig at temperature upto 135° C.

iv) The autoclave shall be insulated with 50 mm thick resin bonded glass wool to minimise heat loss and restrict the skin temperature within reasonable limits so as not to cause burn due to accidental touch.

v) Pipes and fittings shall be of stainless steel and bronze.

vi) Key locked main power switch should be provided for additional safety and security.

vii) The autoclave shall be provided with a vacuum pump of required capacity. The vacuum break vent line shall be protected with HEPA with provision for in-situ filter decontamination of filter before removal.

viii) The Double Door Autoclaves in BSL-3 and Animal Facility shall be installed flushed and provided with Bioseal to prevent ingress of air from autoclave sealing diaphragm due to lab operating pressure.

ix) The autoclave chamber shall be tested to 1.5 times of the working pressure, sterilization jacket to twice the working pressure. The test pressure will be maintained for a minimum of 2 hours.

x) The vacuum line, blow down valve, rupture disk etc. shall meet biosafety requirements with suitable protection and provided with hydrophobic HEPA ffiltered vent having provision for decontamination of filter before removal/change of filter.

CONTROLS

i) The autoclave shall be fully programmable type with microprocessor and designed to control and monitor a wide variety of sterilizing cycles, depending upon the load to be sterilized. A manual operation facility shall also be provided as a standby in case of control failure. The automatic control shall have following features (but not limited to) :

- Indication Alarm in case of any cycle interruption or cycle failure
- Printer to print relevant information concerning operation during the cycle such as temperature, pressure, cycle time etc
- Cycle parameters should be adjustable with restricted access code to prevent adjustments by non authorized persons
- Low water level in steam generator
- Following safety features to prevent the opening of door in following instances (but not limited to).
  * When the chamber is pressurised
  * When the decontamination/sterilization cycle has not completed

ACCESSORIES

The Autoclave shall be complete with following accessories :

- Jacket Steam Valve
- Chamber Steam Valve
- Safety Valve Exhaust to Drain
- Pressure Reducing Valve
- Jacket and Chamber Steam inlets
- Moisture separator
- Rupturing Disc
- Non return valves and strainers
- Steam Filter
- Solenoid Valve/s
- Vaccum break valve
- Vacuum break filter
- Compound Gauge
- Pressure Gauge
- Safety Valves
- Steam Trap
- Jacket drain valve
- Digital Thermometer
- Electrical Control Console/Panel with printer to record autoclaving cycle data.

Each Autoclave shall be provided with compaticle capacity in-built steam generator.

OPERATING AND PERFORMANCE PARAMETERS

i) The vacuum autoclave shall give a minimum of three vacuum cycles to purge air from the autoclave chamber and leave no air pockets.

ii) Operating temperature shall be 121° C or 135° C, as per programmed cycle parameters

iii) The autoclave should completely kill the approved biological indicator at the maximum design capacity. Biological indicator shall be Bacillus stearothermophilus spores using vials or spore strips, with at least $1X10^6$ spores per millilitre. The steam condensate shall meet EU WFI Specifications.

iv) Once the bio-contaminated waste has been loaded from the containment side, the unloading door of the Autoclave shall not open till the decontamination cycle has successfully completed.

INSTALLATION

The autoclave shall be installed/ mounted on a sturdy tubular frame of stainless steel and shall include incoming water connections, drain connection, power connection etc., complete as required.

SECTION - V

TESTING, COMMISSIONING & VALIDATION

1.0 TESTING, COMMISSIONING AND VALIDATION

a) After completion of the construction and installation works, all the equipment, systems and services shall be commissioned and tested to check the operation and performance of each of the equipment and system.

b) Once all the equipment and systems are found to be working satisfactory, the Validation of the BSL-3, BSL-2 Laboratory and Animal Facility shall be carried out by the Contractor in the presence of authorized representatives of HITES/Client.

c) Validation of BSL-3 and BSL-2 Laboratory shall be carried out in accordance with the DBT Guidelines. During the validation process, operation and functioning of complete installations shall be checked to verify that the equipment and systems are delivering the desired and approved performance results. It will be checked to ensure that all the biosafety and biosecurity requirements are met, are in place and are functional.

d) The validation of Animal Facility shall be done as per the approved designs to check and verify the actual performance of equipments, systems and installation.

e) Before start of the validation process, the Contractor shall submit a detailed validation document giving details of validation checks and tests to be performed, the acceptance criteria with respect to relevant guidelines and standards, as per the approved designs & drawings and the formats for recording the check and test results.

f) After completion of the validation process, the Contractor shall compile the validation results and submit to HITES/Client.

g) The Contractor shall provide all the test and measuring instruments, tools, tackles, manpower etc. required for the Testing, Commissioning and Validation Process.

h) The works shall be accepted as COMPLETED only after successfull completion of Validation ofBSL-3 High Containment Laboratories

i) The Validation Tests and Checks for BSL-3, BSL-2 Laboratory and Animal Facility shall include, but not limited to, the following:

- Testing of Containment Barrier Integrity
- Testing of Autoclaves (Min 5 cycles)
- Testing of BLED Plant (Min. 5 Cycles)
- Testing and Validation of Dynamic Box
- Testing and Validation of HEPA Filters
- Testing of Safe Change of HEPA Filters
- Leakage Testing for Containment Housing
- Testing of Room & Zone Pressure Gradient
- Testing of Supply & Exhaust Air Quantity and calculation of ACPH
- Testing of Room Temperatures
- Testing of Access Control System
- Testing and validation of shower system
- Testing of ventilated garment cabinets
- Operation of Decontamination cycle in Fumigation Airlock
- Testing and validation of complete HVAC system operation
- Testing and Validation of complete Electrical system operation
- Testing and validation of Supply and Exhaust Fan interlock
- Testing and Validation of Fire Alarm and Fire Fighting System
- Testing and Validatiion of DG set operation
- Testing and Validation of Normal to Emergency and Emergency to Normal power shift
- Any other check & tests to ascertain that there is no breach in biosafety

2.0 EXTERNAL VALIDATION

HITES/Client may appoint an Expert Committee for Validation of BSL-3 Laboratory. The contractor shall provide all the required assistance for carrying out the validation by the Expert Committee.

The Contractor shall extend full cooperation and provide the validation instruments, tool, tackles and manpower etc., as required and asked by the HITES/Client during the External Validation.

3.0 DOCUMENTS TO BE SUBMITTED ON COMPLETION

a) On Completion of the works, the Contractor shall submit the following documents to HITES/Client in three sets:
   - Complete Set of 'AS BUILT DRAWINGS'
   - Operation and Maintenance Instructions & Manuals for individual Equipment and Systems
   - Recommended List of Spares and Consumables
   - Preventive Servicing and Maintenance Schedule

b) The Contractor shall submit the Technical Specifications and Data sheet for all the equipment/s and systems supplied and installed.

c) The Contractor shall submit a written undertaking that spares and after sales services for all the equipment, systems and services installed in the facility shall be made available for a period of 10 years from the date of handing over the facility.

SECTION - VI

ANNUAL OPERATION SERVICES

1.0 OPERATION SERVICES

1.1 After Completion of Works and Handing Over, IAV/Client may require the Contractor to provide Comprehensive Operation services for a period of upto 3 years at the quoted and pre-approved rates invited in the tender, and enter into a contract for comprehensive annual operation and maintenance services with the Contractor.

1.2 The Comprehensive Operation Services to be provided by the Contractor shall include:

a) Providing qualified, experienced and trained manpower for handling Operation of the Laboratory Facility on day-to-day basis as per the terms of the tender.
b) To carry out routine and preventive servicing and maintenance of the equipment, system and services installed under the contract like Chillers, AHU's, Exhaust Blowers, Autoclaves, Effluent Decontamination System, Air compressors, Pass Box, Access Control System, Lifts, BMS, Internal Electrical Power distrubution system, Fire Alarm system etc., CCTV system, DG set, Fire Fighting System, Water distribution system, water softening plant etc.
c) Attend to and carry out any breakdown maintenance works required from time to time, as and when it occurs and notified by the Client.
d) Maintain daily Log Sheet of laboratory operating parameters.
e) Maintenance of electrical system, services and construction works executed by the contractor.
f) Annual Validation of the BSL-3, BSL-2 Laboratory and Animal Facility
g) Calibration of mesauring instruments like pressure gauges, temperature sensors etc.

1.3 In case the performance of the Contractor during the Operation Services is found to be un-satisfactory, the Client may terminate the Contract by giving one month notice to the Contractor.

1.4 During the operation period, the RESPONSE TIME by the contractor should not exceed 24 hours from the time the breakdown intimation is given by the user.

1.5 During the operation period, it is expected that the Contractor shall attend the breakdown and rectify the fault/s promptly with minimum possible downtime. The maximum permitted DOWNTIME shall be 48 Hours from the time the intimation is given by the user.

If the repair/rectification is not carried out by the Contractor within the maximum permitted DOWNTIME, the Employer shall charge penalty, for each breakdown instance, subject to a maximum of 10% of the Annual Contract Value, as follows:

Above 48 hours & Below 96 hours - Penalty of 1% of the Annual Contract Value

Above 96 hours & Below 192 hours - Penalty of 1.5% of the Annual Contract Value

Above 192 Hours - Penalty of 2% of the Annual Contract Value and get the work repair/rectification done from third party at the Contractor's Risk and Cost

1.6 The contractor shall maintain sufficient Inventory of required spares and consumables at site to minimize the downtime and to ensure smooth operation and functioning of the Laboratory.

1.7 Before entering into the Operation Contract, the Contractor shall submit details of manpower proposed to be deployed at site, detailed schedule of preventive servicing and maintenance works, the formats for maintaining daily log sheet and servicing and maintenance records and details of spares and consumables to the Client.

1.8 Payment for Operation Services shall be made by the Client to the Contractor on quarterly basis after satisfactory completion of the services and production of the bills and other supporting documents.

SECTION - VII

COMPREHENSIVE ANNUAL OPERATION & MAINTENANCE SERVICES

1.0 COMPREHENSIVE ANNUAL OPERATION &MAINTENANCE SERVICES

1.1 The comprehensive annual operation & maintenance will commence after the prescribed DLP and operation services of three years i.e from the fourth year onwards from the date of handing over of the facility. The Contractor has to provide Comprehensive Operation and Maintenance services for a period of upto 7 years at the quoted and pre-approved rates invited in the tender, and enter into a contract for comprehensive annual operation and maintenance services with the client.

1.2 The Comprehensive Operation and Maintenance Services to be provided by the Contractor shall include:

a) Providing qualified, experienced and trained manpower for handling operation of the Laboratory Facilities on day-to-day basis as per the terms of the tender.
b) To carry out routine and preventive servicing and maintenance of the equipment, system and services installed under the contract like Chillers, AHU's, Exhaust Blowers, Autoclaves, Effluent Decontamination System, Air compressors, Pass Box, Access Control System, Lifts, BMS, Internal Electrical Power distrubution system, Fire Alarm system etc., CCTV system, DG set, Fire Fighting System, Water distribution system, water softening plant etc.
c) Attend to and carry out any breakdown maintenance works required from time to time, as and when it occurs and notified by the Client.
d) Maintain daily Log Sheet of laboratory operating parameters.
e) Providing Spares and Consumables for the equipments provided and installed in the facility under the contract including Gaskets for Doors, Autoclaves & Pass Boxes, Valves, Light Fittings & Fixtures, switches and sockets etc. The contractor shall maintain suitable inventory of critical spares to avoid disruption of laboratory functioning.
f) Maintenance of electrical system, services and construction works executed by the contractor.
g) Annual Validation of the BSL-3, BSL-2 Laboratory and Animal Facility
h) Calibration of measuring instruments like pressure gauges, temperature sensors etc.

1.3 The following works and consumables shall not be included and covered in the scope of Contractor in the Comprehensive Operation and Maintenance Services:

a) Supply of power, water and fuel
b) Internal and External Painting of the Building
c) Chemicals/reagents for use in laboratory for Fumigation/ Decontamination
d) Change of batteries for UPS and Inverter
e) General Housekeeping works including associated consumables
f) Operation of Lifts.
g) Maintenance of equipment and items supplied directly by IAV/Client
h) Damage or loss of item/equipment caused due to fire and theft

1.4 In case the performance of the Contractor during the Comprehensive Operation and Maintenance Services is found to be un-satisfactory, the Client may terminate the Contract by giving one month notice to the Contractor.

1.5 During the operation and maintenance period, the RESPONSE TIME by the contractor should not exceed 24 hours from the time the breakdown intimation is given by the user.

1.6 During the operation and maintenance period, it is expected that the Contractor shall attend the breakdown and rectify the fault/s promptly with minimum possible downtime. The maximum permitted DOWNTIME shall be 48 Hours from the time the intimation is given by the user.

If the repair/rectification is not carried out by the Contractor within the maximum permitted DOWNTIME, the Employer shall charge penalty, for each breakdown instance, subject to a maximum of 10% of the Annual Contract Value, as follows:

Above 48 hours & Below 96 hours - Penalty of 1% of the Annual Contract Value

Above 96 hours & Below 192 hours - Penalty of 1.5% of the Annual Contract Value

Above 192 Hours - Penalty of 2% of the Annual Contract Value and get the work repair/rectification done from third party at the Contractor's Risk and Cost

1.7 The contractor shall maintain sufficient inventory of required spares and consumables at site to minimize the downtime and to ensure smooth operation and functioning of the Laboratory.

1.8 Before entering into the Comprehensive Operation and Maintenance Contract, the Contractor shall submit details of manpower proposed to be deployed at site, detailed schedule of preventive servicing and maintenance works, the formats for maintaining daily log sheet and servicing and maintenance records and details of spares and consumables to the Client.

1.9 Payment for Comprehensive Annual Operation and Maintenance Contract Services shall be made by the Client to the Contractor on quarterly basis after satisfactory completion of the services and production of the bills and other supporting documents.

SECTION - VIII

LIST OF PROPOSED AND PREFERRED MAKES / MANUFACTURERS

A. CIVIL & ASSOCIATED WORKS

Sl. No	Details of equipment/ material	Make/ Manufacturer
1.	Acoustical Panelling	ECOTONE/Armstrong/ Anutone
2.	Adhesive for Ceramic tiles/ Stone/ Stone Sealers	Cico / Pidilite / Ardex Endura / MYK Laticrete/ Fosroc/ Berger/ Sika/ Cera-Chem
3.	Adhesive for Wood Work	Fevicol/ Vamicol/ Dunlop/ 3M/ Sika
4.	Adhesive Tape	3M/ Norton/ BOPD/ TESA
5.	Aluminium Accessories and Hardware	Classic/ Crown /EBCO /Hardwyn/ Doorking
6.	Aluminium Composite Panels	Aludecor / Alucobond /Alstone/ Reynobond/ Alpolic/ Virgo/ Alstrong/ Viva/ Eurobond
7.	Aluminium Die-Cast handles &two point locking kit	Giesse / Securistyle / Alu – alpha
8.	Aluminium Extrusion/ Sections	Hindalco / Jindal / Bhoruka/ Nalco / Halco Aluminium Extrusions
9.	Anchor Fastner/Dash Fastner	Hilti / Fischer /Bosch/ Wurth/ Koncept/ Canon
10.	Anti – Termite Treatment	It should be done by permanent members of IPCA as approved by Engineer-in-Charge.
11.	APP Polymeric Polyethylene Felt	BITUMAT/ STP/ Bengal Bitumen
12.	Back up rod	Supreme Industry/ SYSTRANS Polymers/ Backer Rod Mfg. Inc.

13.	Batch Mix Concrete (BMC) / Ready Mix Concrete (RMC)	The contractor to install his own computerized batching plant of suitable capacity and arrange for Transit Mixers, pumps etc. as per approval of Engineer – In- Charge. OR The RMC shall be procured from the source as approved by Engineer- In- Charge. RMC producing plants of the main Cement producers shall be preferred.
14.	Bitumen	Indian Oil, Hindustan Petroleum, Bharat Petroleum
15.	Cement	Refer GoK Circular No.24/2022-Fin dtd 19.03.2022. BIS mark with IS code No. and License number (CM/L.no) is insisted in Cement and to be approved by Engineer-in-Charge
16.	Cement: White	Birla White / JK / Ultratech/ Lafarge/ Travancore
17.	Cement bonded particle board	Bison Panel/ Viroc/ Viva/ HIL/ NCL
18.	Clean Room Wall Panels with/ without return air risers, Doors/ windows etc.	CLESTRA/ NICOMAC / HEMAIR / GMP / E-PACK
19.	Concrete Additive	Pidilite / Fosroc / MC Bauchemie /Sika/ Cico/ CHRYSO/ STP Ltd./ Asian Fairmate/ MYK Arment/ Berger/ MC Bauchemie/ Sunanda Chemicals/ Cera Chem/ Fibrex/Tremco
20.	Cover /Spacer Block	Fosroc / Astron/ KK
21.	Curtain Rod/ Drapery Rod/ Venetian Blinds	Vista / Mac/Decor/ Deck / Hunter /PHIFER
22.	Curing Compound	Pidilite / Fosroc / Sika/ Cico/ STP Ltd./ BASF/ MYK Arment/ Berger/ MC Bauchemie/ Cera-Chem
23.	Crash Guard/ Corner Guard	Construction Specialities/ Gradus Inprop India Pvt. Ltd./ PD Projects/ DK Engineering Group
24.	Coupler (mechanical)	Dextron/ Sanfield/ Usha Martin/ G- Tech Splicing/ Ascon

25.	Carpet Flooring & Skirting (Flotex)	Forbo/ Polyflor/ Tarket		
26.	Compressed Chequered tiles	Somany/ Kajaria/ Nitco/ Orient/ Johnson		
27.	Door closer / Floor spring	Godrej/ Dorma/ Geze/ Hafele/Assaabloy/ Hormann/ KICH/ Hardwyn/ Doorking/Everite/Hardwyn/Hardima.		
28.	Door Locks & Latches	Godrej / Harrison / Dorma/Link/ GEZE/ Hafele/ Hettich/ Hormann/ Ozone/ ACME/ Hardima/ Mobel		
29.	Door Seal	Anand Reddiplex/ Enviroseal / STP		
30.	Door Shutters- Flush & Factory Hot Pressed Laminated Door Shutters	Duro / Greenply/ Archidply / Century / Merino/ Jayna / Kitply /JAIN DOORS/ AK Plywood		
31.	Doors & Windows Fixtures / Fitting.	Godrej/Ebco / Hafele/ Geze /Assaabloy / Hardwyn/ Hettich /Dorma/Hormann/ Everite/ Classic/ Crown/ Earl Bihari/Global/ Crown/Hardima		
32.	Epoxy Flooring	Fosroc/ Dr. Beck/ Famaflor / STP/Asian Paints/ MYK Arment/ Berger/Ardex Endura/ Cera-Chem/ BASF/Apurva		
33.	Epoxy Mortar	Fosroc/ Sika/ MYK Arment/ Chryso/ BASF/ Pidilite/Dr. Fixit/Asian Paints/Cico/ Berger/ Cera-Chem		
34.	Extruded Polystyrene Board	Styrofoam by DOW Chemical's / Insuboard by Supreme Industries /STP Ltd.		
35.	False Ceiling - Calcium Silicate Boards & Tiles	Armstrong / Hilux	/ Saint	Gobain

		(Gyproc)/Aerolite/	India	Gypsum/
		RAMCO (Hilux)/		
36.	False Ceiling – Metal	Armstrong / Hunter-Douglas / USG-Knauf/ Saint Gobain/ Unimet/ DEXUNE/ Everest		
37.	False Ceiling - Mineral fibre	Armstrong / Decosonic / USG-Knauf/ AMF / Saint Gobain / DEXUNE		
38.	False Ceiling – GRG Ceiling Tiles	Saint Gobain /Diamond/or equivalent		
39.	False Ceiling/ Dry wall partition system (ceiling/hanging sections)	Gyproc/ USG-Knauf/Armstrong/ Western /DEXUNE/ Hunter-Douglas		
40.	Fire Rated Doors & Frames with accessories	Shakti-Hormann / Navair / Pacific/Promat/Bhawani Fire Protection/ Sukriti Fire Door/ ASES/ Jain Doors/ Tata Pravesh/ Godrej/ Promat.		
41.	Fire Rated Glass	Asahi India Safety Glass Ltd./ Saint Gobain/ Pilkington, Schott, Pyroguard, Glaverbel/ Modi/ Schott Pyran		
42.	Fire Retardant Paint	Viper (Navair) FRS 881/ Nullifire/ STP / Asian/ Berger		
43.	Fire Seal	Sealz/ Alstroflam/ Abacus		

44.	Fire: Door Closures, Mortise Dead locks, D- Type Pull Handles, Hinges, Panic Exit Devices, Tower Bolts	Becker Fire Solution/ Ingersoll Rand/ Dorma/ Godrej/ Geze/ Hafele/ Shakti-Hormann/D-Line/ Suzu/ Nulite/ Dorset/ Auto Ingress/ Bhawani Fire
45.	Fire: Sealant	Birla/ 3M/ Hilti
46.	Floor Hardener	Pidilite / SIKA/ Fairmate / BASF/STP Ltd./ Fosroc/ CHRYSO/ MYK Arment/ Asian Paints/ Berger
47.	Flooring -Synthetic Acrylic (as per ITF Specifications)	Rebound/ PACE Court/Nova Cushion/ Sports Master
48.	Glass : Float / Mirror /Structural Glazing /Toughened Glass	Modiguard / Atul / Saint Gobain/ Asahi India Safety Glass Ltd / Sisecam (HNG)/ Pilkington/ Cera-Chem
49.	Glass Wool / Insulation Boards	Rockwool / UP Twiga / Lloyd Insulation/ Pidilite/ Berger
50.	GRC Jali	Unistone/ Kuber Everest Fibrostone/ Composites/ Birla
51.	Grout: Non-Shrink	Fosroc / Sika/ Pidilite / ST MYK Arment/ MC P/ Bauchemie/ Cera-Chem
52.	Grouting Compound	Ardex Endura/ Pidilite/ Laticrete/ Unitile/ STP/ Asian Paints/ MYK Arment/ Berger / MC Bauchemie /Cera-Chem

53.	Gypsum Board / Gypsum False Ceiling/ Gypsum Partitions	USG Knauf / Lafarge / Saint Gobain (Gyproc)/ Armstrong / India Gypsum, /Boral
54.	Gypsum Plaster	Ferrous crete / Ultratech/ Saint Gobain / Asian Paints Marvelloplast /USG Knauf
55.	Laminates/ Veneers	Century/ Archidply /Greenlam/ Formica/ Sunmica /Merino/Decolam, / Green Ply
56.	Lead Lined Door	REBBON/ Kutty's/ AHALDA/ Navair/ Shakti-Hormann/ Metaflex
57.	Modular Grab bars and Disabled Hardware	Dorma / D-line/ KIC Jaquar/ H/ Hindware/ Kohler
58.	Modular SS Railing System	Metallica India / D – Line International Denmark / Mobel Hardware /KICH/ Koncept
59.	Modular Kitchen Chimney	Hindware/ Elica/ Glen/ Faber/ Sleek.
60.	Neutron Shielded Door	Ray-Bar Enggcorp / A-FabcoIn/ A&L shielding INC/ Accurate Radiation Shielding
61.	OT: Conductive Tile Flooring: ESD-Control Tile Flooring	Tarkett/ Gerflor / Armstrong / Forbo/ Trilux

62.	Paints - Cement Based	Snowcem Plus/ Berger/ Nerolac/ TATA Cem/ Asian Paints/ STP Ltd./ Dulux/ Jotun
63.	Paints - Epoxy paint	Akzonobel DULUX/ Nerolac / Cico/ Sika / BASF / Berger / Pidilite/ STP Ltd./ Fosroc/ MC Bauchemie/ Jotun/Cera-Chem
64.	Paints - Oil Bound Distemper / Acrylic Washable Distemper /Plastic Emulsion Paint	Akzonobel DULUX/ Asian Paints/ Berger / Nerolac /Jenson & Nicholson/ Jotun/ Nerolac/ Nippon

B.

65.	Paints - Plastic Emulsion Paint (exterior)	Asian Paints (Apex Ultima)/ Berger (Weathercoat all Guard)/ Akzonobel (DULUX weather shield max)/ Jotun/ ICI / Nerolac.
66.	Paints - Synthetic Enamel Paints	Akzonobel DULUX (Gloss), Berger (Luxol Gold), Asian Paints (Apcolite), Goodlas Nerolac (Full gloss hard drying), Jenson & Nicholson (Borolock) Jotun ICI Dulux (Gloss)
67.	Paints - Texture paint	Berger / Spectrum / Unilite/ Heritage /Asian Paints / Akzonobel DULUX/STP Ltd./ Jotun/ICI/ Nerolac
68.	Paint: Anti-Fungal	Sika by Liquid Plastic/ Viesmann/ SSK/ TRILUX/ STP Ltd./ Berger/ Ardex Endura/ Cera-Chem
69.	Paint-Wood Finish (Melamine & PU)	Nippon/Jivanjor/ Asian Paints / Akzonobel/ Berger
70.	Putty (Wall)	Ferroscrete/ JK/ Birla/ Berger/ Asian Paints
71.	Paver blocks / Tiles (All Types)/ Grass crete pavers	KK / Uni Stone Products (India) Pvt. Ltd/ Hindustan Tiles/ NITCO/ PAVIT/ ULTRA/ DURACRETE
72.	Plywood/Block board/Ply board	Duroply / Greenply/ Archidply/ Century/ Kitply/ National / Anchor/ Merino / Jayna

73.	Polycarbonate Sheets	Danpanlon India/ Gallina/ Sabic Lexanc/ Ultralite/ Polygal / Coxwell Domes / GE Plastic / Skyarch/ Polytechno/ Tuflite/ Palram
74.	Pre-coated Galvanised Steel Sheet/ Pre- coated Puff Sheet roofing	Tata BlueScope / Llyod Insulations India Ltd / S.R. Metals/Interarch / Bhushan/ Essar/Everest
75.	Pre-Laminated Particle Board	Novapan /Century / Greenlam / Merino / Archidply/ Action Tesa/ NCL/ AK Plywood/ Greenply/Everest /MARINO
76.	PVC continuous fillet for periphery packing of glazings / Structural/ Glazing	Roop / Anand / Forex Plastic/ Nagalia/ Trading Company
77.	PVC Doors	Sintex/ Polyex/ Rajshri
78.	PVC Flooring	Tarkett Floors / LG Floors / Gerflor /Premier Vinyl flooring / Regent/ Armstrong / Responsive/ Wonderfloor
79.	Powder Coating Material pure Polyester	Jotun / Berger / Goodlass Nerolac
80.	PVC Water Stops	Prince /Supreme/ Finolex/ Maruti Astral/ Aarthi Cable & Compounds Compounds/ Sika
81.	RF Shielded Door	ETS Lindgern/ Synchrony Agency/ Huaming EMC India
82.	Reinforcement Steel / Structural Steel	Refer GoK Circular No.24/2022-Fin dtd 19.03.2022. BIS mark with IS code No. and License number (CM/L.no) is insisted in Steel and to be approved by Engineer-in-Charge
83.	Structural Steel (Hollow Sections)	SAIL/ RINL/ TATA Steel Ltd./ Jindal Steel & Power Ltd./ Apollo Tubes
84.	Restroom Cubicles	Merino/ Centur Greenlam/ Action y/

		Tesa
85.	Sealant: Poly-sulphide	Pidilite / Fosroc / CICO / Sika /Berger/ Dr. Fixit/ Chowksey Chemical/ Wacker/Asian Smartcare/ MYK Arment
86.	SFRC / RCC Manhole Covers/ Perfect RCC Grating	KK Manholes / SK Precast Concrete/ Advent concrete vision / Daya concrete
87.	Silicon sealants /Weather Sealant / Structural Glazing Sealant	GE- Silicon / Pidilite / Forsoc / Cico /Dow Corning / Sika/ Wacker/STP/ Asian Smartcare/ MYK Arment/ Berger / Cera-Chem
88.	Stainless Steel	Salem Steel/ Jindal / TATA Steel/ SAIL
89.	Outdoor Sports Flooring	Great Sports Infra/PORPLASTIC/Sunflex
90.	Stainless Steel bolts, Screws, Nuts & Washers	Kundan / Puja / Atul/ GKW/Alloy
91.	Stainless Steel Clamps	Hilti /Intellotech / Koncept/ WURTH
92.	Stainless Steel CP Grating	Chilly / Camry/ Neer or equivalent
93.	Stainless Steel D-handles	D-line / Giesse /Dorma/ Hormann
94.	Stainless Steel Friction Stay	Earl Bihari / Securistyle / EBCO
95.	Stainless Steel Hinges/Handles/Door Window Fixtures	Hettich/ Godrej/ Dorma Hafele/ / Gezze/ KICH/ Dorset/ / Hormann Sleek

96.	Sunken Portion Treatment	Choksey / Sika / CICO/ MC Bouchemie / BASF/ Berger / MYK Arment / Bostik/ Dr. Fixit/ Ardex Endura/ Cera-Chem
97.	Super plasticizer	CICO/ Roffes Construction Chemicals/ Pidilite / Berger/ Asian Paints/ MYK Arment/ MC Bauchemie / Bostik/ Cera-Chem/Krytone
98.	Tiles: Glass Mosaic Tiles	MRIDUL/ BIZZARE/ Italica/ Bizzaza. Pallidio
99.	Tiles: Glazed /Ceramic Tiles	Kajaria / Somany/ CE / RAK/ RA Johnson / AGL/ Varmora
100.	Tiles: Heat Resistant Terrace Tiles	Thermatek/ Hindustan/ Johnson
101.	Tiles: Vitrified Tiles (Double / Multi Charged)/ Germ free/Full body)	Kajaria / Somany/ RAK / CERA/ Johnson/ AGL/ Varmora
102.	Vacuum Dewatered Flooring	Tremix / Sun Build / Avcon technics
103.	Veneered Particle Board	Duro / Greenply / Century / Novapan / Action Tesa
104.	Water Proofing Materials	BASF/ Fosroc / Sika / CICO / STP / Pidilite/ CHRYSO/ PENETRON/ Asian Paints / KRYTON/ XYPEX/ MYK Arment/ Berger/ MC Bauchemie/ Tikidan/ Ardex Endura/ Cera-Chem/ Sunanda Chemicals/ IWL/Tremco

105.	Water Proofing Compound (Crystalline)	Xypex Construction Chemicals/ Kryton/ Penetron/ Pidilite/MYK Arment/ Burger/Asian Paints/Sunanda Chemicals/Cera-Chem
106.	Wooden Laminated Flooring	Euro / Pergo/ Green Deco , Krono, Egger, Harro , Armstrong, Kaindl/ Action Tesa
107.	Auditorium Chairs	Godrej /Indo/ Wipro/ Bonton /Durian
108.	Expansion Joints	Sanfield (India) Ltd., MIGUA, TRISTAR, Z- TECH
109.	Raised/ False Flooring	UNIFLOOR, UNITILE, CAMFLOR
110.	uPVC door & window system	Fenesta, NCL Veka, Rehaue, Aluplast / Deceunick / AMD Overseas/ Lingel/ CASSA/ Evolution/ Kommerling/ Duroplast/Aparna Venster
111.	High Pressure Laminates	Greenlam/ Merino/ Virgo
112	Prefabricated wall and ceiling panels	Nicomac/I-Clean/GMP

113	View Panels	Nicomac/I-Clean/GMP
114	Laboratory Doors	Nicomac/I-Clean/GMP

C. ELECTRICAL & ASSOCIATED WORKS

Sl No.	Materials	Manufactures
1	11 KV VCB Panel Board	Siemens/ ABB/ Crompton Greaves/ Kirloskar / L&T/Schneider Electric
2	11 KV XLPE Cable	Gloster/ Havells/ Nicco/ Finolex/ KEI/ Polycab/ Bonton/ Rallison/ RR Kable/Avocab
3	Compact or Unitized Substation	Crompton Greaves/ Kirloskar/ ABB/ Siemens/ Schnieder/ Megawin / Intrans/ Resitech/ KEL
4	Bus Duct/rising mains	L&T/ Siemens/ ABB// Schneider /Legrand
5	Diesel Engine	Cummins/ Kirloskar/ Caterpillar/ Greaves Cotton
6	Alternator	Stamford/ Kirloskar/ Leroy Somer & Control/ Crompton Greaves/ Caterpillar
7	Battery	Exide / Standard Furukawa/ Amar Raja
8	L.T. Cables	Gloster/ Havells/ Nicco/ Finolex/ KEI/ Polycab/ Bonton/ RR Kable /Avocab
9	PVC insulated Wires/ Telephone wires & cables, coaxial cables	Gloster/ Havells/ Batra Henlay/ KEI / Polycab / Finolex/ RR Kable/ Bonton/ NEC/ AKG/ Anchor Panasonic
10	Telephone Tag Blocks	Krone / Hensel
11	Switch & sockets	Clipsal (Schneider) IP 66 rated for BSL-3 Lab, Modular - Havells (Crabtree-Murano)/ Schnieder (Zencelo)/ Wipro (North West-Platia)/ ABB (Ivie) / Anchor (Roma Plus)/ Honeywell (Blenze Plus)/ Legrand (Myrius)/ Panasonic (Europa)/ L&T (Englaze)/ Indoasian (Shynora)
12	Industrial Sockets & Plugs	Siemens/Schneider/ Havells/ABB
13	PVC Conduit	Clipsal/ JPC Pipes/ AKG / Anchor panasonic / Balco / Precision

14	Lighting fixtures (LED)	Philips/ Crompton /Wipro / Lighting technologies/Panasonic/Havells For BSL 3 - IP 65 or better
15	Ceiling Fan/ Exhaust fan	Crompton Greaves/ Alstom/ Usha/ Bajaj
16	Main LT Panel & MV Panels	CPRI approved Manufacturer
17	UPS & Inverter	Emerson (Vertiv)/ Schnieder (APC)/ Eaton/ Socomec/ Riello/Fuji Electric/ Delta
18	Air Circuit Breakers	L&T/ Siemens/ ABB/ Schneider /Eaton
19	MCCB	L&T / Schneider / ABB / Siemens / Legrand / Eaton
20	MCB-DB's, MCB, ELCB RCCB / MCB-Isolator etc	Hager/ Havells/ Legrand/ L&T/ Schneider/ ABB/ Siemens/ Eaton/ Anchor/ HPL/ C&S/ Indoasian
21	SDFU	L&T/ABB / Siemens/ Schneider /Eaton
22	Power Contactors	L&T/ Siemens/ Schneider/ ABB / Eaton
23	LIFTS	OTIS/ Kone/ Scheindler/ Mitubshi./ Johnson/TKE
24	FDA System	Honeywell/ Bosch/ TYCO/ Siemens / Schrack
25	P.A. System	BOSCH/ Bose/ Honeywell/Aties
26	CCTV System	Honeywell / Pelco / Bosch / Axis /Tyco
27	Lamps & Push Buttons Ammeter/Voltmete	L&T/ABB/ Siemens/ Schneider/AE/Salzer/Kaycee
28	CT/PT	Pragathi/AE/Kappa/Rishabh/ Intrans/Resitech
29	Relay	L&T/ABB/ Siemens/ Schneider

C. HVAC & ASSOCIATED EQUIPMENTS WORKS

Sl No.	Materials	Manufactures
1	Air cooled chiller	Voltas / Blue star/ Carrier /Hitachi/Daikin/York/Trane
2	Double skin type AHU	VTS/Systemair/Waves/Edgetech
3	Primary & Secondary Pump	Xylem/Amstrong/Grundfos
4	Pressure expansion tank & Air Separator	Amstrong/Anergy
5	Humidifier	Rapid cool/Emerald/Khokar
6	Pressure Gauge	Fiebig/Wika/H Guru
7	FCUs	Hitech/Carrier/Voltas/Midea
8	Ductable Split(Air Cooled)	Voltas / Blue star/ Carrier /Hitachi/Daikin
9	Split type Air conditioners	Voltas / Blue star/ Carrier/Hitachi/Daikin
10	Auto air vent valve	Rapid control/RB/Anergy

11	Fire damper with controls	Caryaire/ Dynacraft/ Ravi star/Greenheck/Airmaster
12	Thermal/Acoustic insulation along with Adhesive	Armacell/K flex/Euro Bates/ALP
13	Inline Fan	Kruger/Flakt/Comefri/Nicotra/Greenheck/Airmaster
14	Propeller Fan	GEC(Alsthom)/Crompton Greaves/ Khaitan/Usha/Polar
15	Axial Fan	Kruger/ Flakt/Comefri/Nicotra/Greenheck/Airmaster
16	GI Pipes	ITC/ Jindal/Tata/SAIL/HSL
17	MS pipe	ITC/ Jindal/Tata/SAIL/HSL MS
18	Flow switch	Honeywell/Siemens/Rapid control
19	GI Sheets	TATA/SAIL/Jindal/Bhushan Steel
20	Factory Fabricated Duct	Zeco/Roller Star/Multiline/Sevenstar/western air
21	Aluminium Sheet	Balco/Nalco/Hindalco
22	Grilles/Diffusers	Ravistar/Caryaire/ Mapro/Dynacraft/Airmaster
23	Fire dampers (Motorized)	Caryaire/Dynacraft / Ravistar Electric/Greenheck/Airmaster
24	Hot Water Generator	Rapid cool/Emerald/Khokar
25	Gate Valve	Leader/Divine/Sant/Bankim Sarkar/Zoloto/Advance/Audco
26	Butterfly Valves	Advance/Castle / Audco / Intervalve / Arrow / C&R/Zoloto/
27	Balancing Valves	Advance/Castle/Audco/Arrow/C&R/Zoloto/
28	Non-return Valves	Advance/Castle/Kirloskar/C&R/Arrow
29	Pot & Y- Strainer	Emerald/Sant/Rapid cool
30	Three way mixing valves	Stafea/Johnson/Honeywell/Danfoss/Anergy/Rapid controls
31	Two way motorized valve	Staefa/Johnson/Honeywell/Danfoss/Anergy / Rapid controls
32	Actuating motor for 3 way & 2 way valve	Staefa/Johnson/Honeywell/Danfoss/Anergy
33	Ball Valve with & without strainer	Rapid Control/Sant/Leader/Zoloto
34	Expanded Polystyrene	Beardsell Ltd./ BASF/Styrene Packing/ Indian Packaging Industries / Lloyd
35	Thermometers/Pressure Gauge	Fiebig/Emerald/H Guru/Japsin
36	Thermostats/Humidistat s	Honeywell/Penn /Staefa/Johnson/ Anergy /Rapid Controls/Siemens
37	Electric Strip Heaters	Escorts/Daspass
38	Controls	Honeywell/ Johnson / Staefa/Siemens
39	Electric Panels	CPRI approved make
40	Electric Motors	Siemens/ Kirloskar /ABB/ Bharat Bijlee / Crompton Greaves
41	Starters/Contactors	Follow make list under electrical works

42	ACB/MCCB	Follow make list under electrical works
43	Fuse/ Fuse Switch Unit	Follow make list under electrical works
44	Isolation Damper	Trox/Camfil/YIT/Klenzaids or equivalent
45	VAV	Trox/ Aldes/Celmec/Tek-Air (Accutrol) or equivalent
46	HEPA Filters	AAF/Camfil/Klenzaids/Thermadyne/Pyramid/Aerofil
47	Containment HEPA Filter housing	Camfil/YTT/Klenzaids or equivalent
48	VFD	ABB/Siemens/AllenBradley/Danfoss/Yaskawa/A
49	Pressure sensor & transmitter	Honeywell/Dawyer/Danfoss/Siemens
50	Temperature sensor & transmitter	Honeywell/Dawyer/Danfoss/Siemens
51	Humidity sensor & transmitter	Honeywell/Dawyer/Danfoss/Siemens
52	BMS system	AllenBradley / Siemens /ABB/Honeywell/Johnson control
53	PLC	AllenBradley/Siemens
54	Magnehelic Gauges	Dawyer
55	Prefabricated wall and ceiling panels	Nicomac/I-Clean/GMP
56	View Panels	Nicomac/I-Clean/GMP
57	Autoclave	Pharmalab/Klenzaids or equivalent
58	Dynamic Pass Box	Esco/Klenzaids/I-Clean
59	Fire Alarm System	Honeywell/System Sensor/GST/Siemens
60	Door Interlock & Access Control	HID/LG/ESSL
61	Air Compressor	Atlas Copco / Ingersoll Rand

D. FIRE FIGHTING

Sr. No.	Material	List of Makes
1	M.S. Pipe	Jindal Hissar / Tata/Prakash
2	Forged Steel Fittings	True Forge / Sant / Zoloto
3	SS/Brass/Gunmetal Ball Valve (Fullway check and Globe Valves)	Sant / Zoloto / Leader
4	C. I. Double flanged Sluice Valve	Zoloto / AIP / Kirloskar
5	Butterfly Valve/Wafer type check valve	Sant / Zoloto / Leader/Audco/Viking
6	C.I. Double Flanged Non Return Valve	Zoloto / AIP / Kirloskar
7	Fire Hydrant Valve	Newage / Superex / Padmini / Agni/Minimax/AAAG

	8	Fire Extinguishers	Newage / Superex / Padmini / Safeguard/Minimax/Safefire
	9	Fire Hose Pipes, C.P. Hose, R.R.L. Hose, Fire Axe	Newage / Superex / Padmini / Safeguard/Minimax
	10	First Aid Fire Hose Reels (Drum & Bracket)	Newage / Superex / Padmini / Exflame/Safeguard/Minimax
	11	Sprinkler Heads	Tyco / HD / Viking / Getech/Newage
	12	SS Sprinklers Flexible Hose	Tyco / HD / Agni
	13	Pressure Reducing Valve (For Fire)	Zoloto / Sant / Leader
	18	Flow Meter	Scientific / Shali
	19	Suction Strainer	Sant / Leader / Zoloto/Emerald/sks
	22	Pipe Coat Material (Pipe Protection)	Pypkote / Integrated Water proofing co. Madras (IWL) / Coaltek
	23	Flow Switches	System Sensor / Honeywell/Siemens/Rapid control
	26	Fire Brigade Inlet	Newage / Superex / Safeguard/AAAG/Tyco/Viking
	27	Rubber Hose Pipe	Newage / Superex / Safeguard
	28	Hose Couplings Branch Pipe & Nozzle	Newage / Superex / Safeguard
	29	Pressure Switches	Danfoss / H-Guru / Switzer/Indfoss/Waarie
	30	Pressure Guage	H.Guru / FEIBIG/Emaral/wika
	32	Welding Rods	Linclon / Esab/Ador
	33	Paint	Asian / Berger / ICI Dulux
	34	Annunciater Panel for Sprinkler System	Agni / PCD / Safeway
	35	Alarm Valve & Hydraulic Alarm Motor with covering	HD / Mather & Platt / Central Spray Safe / Grinnel
	39	Power Capacitor	L&T / ABB / USHA
	43	Fastner	Hilti/Fisher
	44	Monitor Module	System Sensor / Switzer
	45	Pipe Hanger Supports	Chilly / Camry / GMGR

E PLUMBING

1	G.I / M. S Pipe	Tata, Jindal (Hissar), Prakash Surya , SAIL,Swastik , APL- Apollo

2	G. I Fittings	Unik, Zoloto, Prakash Surya, KS, R- Band, Sun, RR, Sun, Swastik, Jainsons, DRP
3	HDPE Pipes	Jain Pipes, Reliance, Supreme, Oriplast, Vertex, West Well, VectusEmco, Polyefins, Pioneer Plyfab, Texmo
4	DI Pipes	Tata Ductura, Electro Steel, Jindal Hissar
5	DI Fittings	Kartar, Electro Steel, Jainson Kesoram, Tisco, Jindal, HEPC O
6	CI Double flanged sluice valve	Kriloskar,Sant, IVC, Sondhi, Kejriwal, Kilburn , Zoloto,Castle, Leader , L&T, Audco, Honeywell RB , SANT, AIP
7	Pressure reducing valve	Zoloto, Timme, Sks, Sant, Leader, Audco
8	Solenoid Valve	Danfoss, Honeywell Rain Bird, USA, Toro, Nelson
9	Centrifugally Cast (Spun) Iron Pipes & Fittings	Neco, Hepco,SKF, Electrosteel, Saint Gobain ,BIC,,Kapilansh,RPMF
10	Centrifugally Cast (Spun) Iron (Class LA) Pipes & Fittings	NECO, Electrosteel,TATA
11	Pipe Joint Sealant for Cast Iron Pipes	Pipeseal, Dripseal, Pidilite
12	Pre-Fabricated Structural supports and clamps	Chilly, Easyflex, Camry, Euroclamp , Kanwa
13	C. I Manhole covers, Frames & Gratings	Neco, Neer,RIF, BIC, SKF, Jain Spun Pipe CO , HEPCO ,KAJECO , RPMF
14	SFRC Manhole covers & gratings	Kk, OCR, Pragati, T-Con, ,SK Precast Concrete, Advent concrete vision ,Daya concrete
15	Sanitary Fixtures	Hindware, Parryware ,Cera, Somany, Commander , Kajaria Sanitary Ware, ASIAN, Jaguar, RAK, Queo , Kohler
16	CP Fittings	Jaquar, Roca, Parryware, Hindware , Kohler, Grohe, Marc, Kerovit, Somany, CERA, ASIAN, Queo
17	Air purifier container	Euronics, KimberlayClark,Jaquar
18	Bottle Trap	Jaquar, Roca, Parryware
19	Multi-Pan WC Connector	Viega, Mcalpine, Viking

20	Flexible connector for Water supply to Wash basins/ Sinks/Geysors	Vilino Braiden, Asr, Viking, Resistoflex Easyflex, Diamond, Dunlop
21	Concealed Flushing Cisterns	Hindware, ,Commander , Parryware , ,Cera,Kajaria Sanitary ware, Somany, ASIAN , Jaquar
22	Sensor Operated Flushing System	Toshi, Jaquar, aquar ,AOS-Robo,Utec,Ang ash,Euronics, ASIAN , Hindware,Parrywar
23	Liquid Soap Dispensor	Euronics, Kimberlay Clark, Jaquar,Utec,Kopal,ASIAN
24	Health Faucet	Jaquar, Roca, Parryware,
25	Water Meter	Kranti, Sant, Zoloto, Prima, Leader, Capstan, Anand ,Kant,Aristo,Dasmesh, Chambal
26	U-PVC Pipe	Finolex, Supreme, Prakash Surya, Astral, Prince,Polypack, AKG
27	CPVC Pipes & Fittings	Prakash Surya,Supreme, Finolex, AstralFlowguard ,Prince, Astral,Ashirvad,AKG, APL Apollo,Birla HIL ,Truflo (Hindware),Texmo
28	Air Release Valve	Zoloto, Sant, Leader,Azud,API,Bermad,BIR,Kirloskar , Venus
29	Float valve (gunmetal) upto 40mm	Leader, Zoloto, KSB, IVC, Sant, Audco, GPA, jAYCO
30	Float valve (C.I) 50mm and above	Leader, Zoloto, KSB, IVC, Sant, Audco, GPA, jAYCO
31	Altitude / Equilibrium Float Valve	Csa, Honeywell, Danfoss
32	Polythylene water storage tank	Sintex, Sheetal, Polycon, SPL, Vectus,Fusion/Amitex
34	Insulation for hot water pipes	Careflex, Armaflex,, LloydVidoflex insulation,Superion insulation Kaiflex – Kaimann,Thermaflex
35	Insulation for external / exposed hot water pipes	Careflex, Armaflex, Kaiflex, Lloyd,Vidoflex insulation ,Superion insulation – Kaimann,,Thermaflex
36	Pipe protection for external water supply pipes	Pypkote, Makpolykote, Armaflex, Safex ,Makphalt
37	Stainless Steel Sink	Nirali, Jayna, Neelkanth, Cera, ASIA , NIRALI Hindware
38	European WC	Hindware, Parryware, Cera, Somany

39	Washbasin	Hindware, Parryware, Cera, Somany
40	Urinals	Hindware, Parryware, Cera, Somany,Jaquar ,Utec,ASIAN ,kohler, grohe ,marc ,kerovit
41	Electrical Water Heater / Geysors	Crompton, Bajaj, Racold Spherehot , Usha Havells,AO Smith, Orient
42	Stone ware pipes	Perfect, Hind, Rk, Burn,S.K.F,Anand
43	RCC Pipes (NP-2)	Pragati, Lakshmi, Sood&Sood, Jain&Co.
44	Ball Valves	Leader, Sant, Zoloto, AIP,Advance , Audco,L&T, Castle/ Danfoss
45	Butterfly Valves	KSB, Sant, Zoloto, Kirloskar Advance, Audco/ L&T Castle, Danfoss
46	Butterfly Valve with Electric Actuator / Motorized	Danfoss, Zoloto, Castle
47	Plastic Encapsulated Foot Rest	Kgm, Kk, Waltzer
48	C.I. Strainer	Leader, Sant, Zoloto
49	Prefabricated Grease trap	Aco, New Green, Supreme

Note: Wherever makes have not been specified for certain items, the same shall be as per BIS and as per approval of Engineer-in-charge.