SECTION E - STRUCTURAL STEEL WORKS

1.0 SCOPE

1.1 This specification covers the general requirements for supply of all steel items where specified, fabrication, inspection, testing and delivery at site of all fabricated structural steel items.

1.2 This specification also covers design of all connections and substituted members, preparation of all shop fabrication drawings, inspection of fabricated items and the general requirements for erection of structural steel.

1.3 The scope of work also includes but is not limited to proper stacking and storage of fabricated materials, transport from place of storage to place of erection, wherever required. All the works shall be carried out as per approved Quality Assurance procedures.

2.0 APPLICABLE CODES, STANDARDS & SPECIFICATIONS

2.1 The pertinent clauses of the following Indian Codes, Standards and Specification (latest editions including all applicable official amendments, reaffirmations and revisions) shall apply to the material and workmanship covered by this specification. In the event of the conflict of certain requirements between this specification and the codes referred herein, this specification shall govern.

2.2 It is not the intent to specify herein all the codes and standards required for the satisfactory completion of work. The list of codes and standards indicates certain primary codes & standards and not all the codes required for the work under the contract. It is understood that all the following codes and standards shall form the part of this specification whether explicitly indicated or not.

IS: 800: Code of Practice for General Construction in Steel.
IS: 801: Code of practice for use of Cold formed light gauge steel structural members in general building construction.

IS: 803: Code of practice for design, fabrication and erection of vertical mild steel cylindrical welded oil storage tanks.

IS: 806: Code of practice for use of steel tubes in general building construction.
IS: 808: Dimensions for Hot Rolled Steel Beam, Column, Channel and AngleSections.

IS: 813: Scheme of symbols for welding.
IS: 814: Covered Electrodes for Manual Metal Arc Welding of Carbon and Carbon Manganese Steel – Specification.

IS: 816: Code of Practice for use of Metal Arc Welding for General construction in Mild Steel.

IS: 822: Code of Procedure for Inspection of Welds.

IS: 1024: Code of Practice for use of welding in bridges and structures subjectedto dynamic loading

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IS: 1161: Steel Tubes for structural purposes – Specification.
IS: 1182: Recommended Practice for Radiographic examination of Fusion - Welded Butt Joints in Steel Plates

IS: 1200: Method of Measurement in Building Civil Engineering Works. IS: 1239: Mild steel tubes, tubulars and other Wrought steelfittings Part 1 - Mild steel tubes
Part 2 - Mild steel Tubulars and other wrought steel pipe fittings
IS: 1363: Hexagon Head Bolts, Screws and Nuts of product (Parts 1 to 3) GradeC (Size range M5 to M64)

IS: 1367: Technical Supply Conditions for Threaded Fasteners (All Parts)
IS: 1395: Low and medium alloy steel covered electrodes for manual metal arc welding

IS: 1852: Rolling and Cutting Tolerances for Hot Rolled Steel Products. IS: 2062: Hot Rolled low, medium and high tensile structural steel

IS: 2074: Ready Mixed Paint, Air drying, Red Oxide Zinc Chrome andPriming IS: 2595: Code of Practice for Radiographic Testing
IS: 3502: Steel Cheered Plate

IS: 3600: Method of testing fusion welded joints and weld metal in steel (Allparts)
IS: 3658: Code of Practice for Liquid Penetrant Flaw Detection
IS: 3757: Specification for High Strength Structural Bolts
IS: 4000: High strength bolts in Steel Structures - Code of Practice
IS: 4260: Recommended practice for ultrasonic testing of butt welds in ferritic steel
IS: 4353: Submerged arc welding of mild steel and low alloy steel – Recommendations

IS: 5334: Code of Practice for Magnetic Particle Flaw Detection of Welds IS: 5369: General Requirements for Plain Washers and LockWashers IS: 5372: Taper Washers for Channels
IS: 5374: Taper Washer for I Beams
IS: 6610; Heavy Washers for Steel Structures
IS: 6639: Specification for Hexagonal Bolts for Steel structuresIS: 7205: Safety Code for Erection of Structural Steel Work
IS: 7215: Tolerances for Fabrication of Steel Structures
IS: 8500: Structural Steel-micro alloyed (medium and high strength qualities)
IS: 9595: Recommendations for Metal Arc Welding of Carbon and Carbon Manganese Steel

SP: 6(1): Structural Steel Sections
IS: 12843: Tolerances for Erection of Steel Structures

AISC: Specifications for Design, Fabrication and Erection of BuildingsAWS D1.1: Structural Welding code: Steel

3.0 REGULATORY REQUIREMENTS

The work covered in this specification, shall comply with all relevant government and local laws, regulations and standards. For subjects not covered by regulations, codes, standards or specifications, the materials and construction shall be based on good engineering practice, subject to approval by Engineer/ Engineer's Representative.

4.0 SUPPLY AND FABRICATION OF STRUCTURAL STEEL

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4.1 STEEL MATERIALS

Steel materials shall comply with the specifications laid down under clause 2.0 and/or as called for on the design drawings. All materials used shall be new, unused and free from defects.

4.1.1 Steel Supply by the Contractor

All steel and other materials shall be procured and supplied by the Contractor, from the reputed manufactured like SAIL, TATA STEEL, ESSAR and JINDAL. Steel proposed to be procured from other sources shall have prior approval from the Employer before placement of procurement order. However, The Employer reserves the right to accept material from other manufacturers. Steel procured shall conform to the following.

The contractor shall furnish to the Engineer/ Engineer's Representative duplicate copies of all purchase order copies covering the material ordered by him for the project under reference and test reports.

Contractor shall furnish the mill/ manufacturer's test reports, along with the materials and satisfactorily demonstrates the specific grade and quality. Material test certificate shall be original.

All materials required for the work shall be correlated with manufacturers test certificates. In the absence of test certificates, Contractor shall test materials through reputed laboratory approved by Engineer/ Engineer's Representative forestablishing quality at Contractor's cost and as directed by the Engineer/ Engineer's Representative.

Material supplied against this Test Certificates (TC) should have identification stamped or stenciled on them. All such identification markings shall be authenticated by the inspection agency, which has inspected and approved the material.

The Engineer/ Engineer's Representative shall have the right to test random samples to prove authenticity of the test certificates produced by the contractor at the contractor's cost. Any material found not meeting the required specification would be rejected.

Contractor shall use materials for fabrication as specified in the approved drawings. All materials supplied by the contractor shall be in sound condition, ofrecent manufacture, free from defects such as mill scales, slag intrusions, laminations, pitting, flaky, rust etc. and be of full weight and thickness as specified.

Whenever the contractor desires to substitute structural members/shapes, plates for the sizes shown on the drawings, for want of availability of requisite materials, such substitutions shall be made only after authorization in writing by the Engineer/ Engineer's Representative. Engineer/ Engineer's Representative mayalso direct that substitution be made, when he considers such substitution to benecessary.

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4.2 DRAWINGS

Unless otherwise specified, the drawings and specifications are intended to include everything obviously requisite and necessary for proper and entire completion of the work and shall be carried out accordingly for completeness as required.

4.2.1 Contractor's Drawings

(a) Fabrication drawings shall be prepared by the Contractor or through an agency approved by The Employer at his own cost based on the Engineer's/ Engineer's Representative's approved design drawing "Released for Construction" and their subsequent revisions. All the drawings for the entire work shall be prepared in metric units. Drawings shall be prepared in AUTOCAD and the details shall be drawn to the minimum scale as specified under:

(i) Marking Plan: 1:75
(ii) Joint Details: 1:5, 1:10, 1:15
(iii) Elevations: 1:20

(b) Contractor shall not commence detailing unless Engineer's approvals on Contractor's design drawings are officially released for preparation of shop drawings. The contractor shall be responsible for the correctness of all fabrication drawings. Fabrication drawings shall be revised by the Contractor to reflect all revisions in design drawings as and when such revisions are made by the Engineer.

(c) Key plan prepared by the contractor shall indicate the fabrication / erection marking of each member and a table showing the corresponding fabrication drawing number where these members are detailed. Also, each drawing prepared by Contractor shall indicate corresponding Engineer's/ Engineer's Representative's drawing number with revisions.

(d) Each member shall be detailed separately unless members are identical in all respects with no deviation whatsoever. Shop detail drawings shall show all shearing, punching, drilling, bevel cutting, blending, and all welding in complete detail. All connections and splices shall be designed and detailed by the Contractor and clearly shown on the drawings. Bill of material shall show number, size, length, weight and assembly work of each erection piece. Bill of material for each drawing shall include fasteners/bolts, nuts, washers and other accessories complete with specification, size, length, numbers, etc for each erection mark and proper identification for each joint. Bill of materials shall be prepared erection mark wise, showing weight of each component part and total weight of each erection mark. All revisions after initial issue of a drawing shall be clearly indicated with issue number and date of revision.

(e) Each drawing prepared by the Contractor shall clearly indicate Names of Engineer, Engineer's Representative, Contractor, Project Title, Title of drawing, Scale, Notes, Details of revisions carried out etc. All titles, noting, marking and writings on the drawing shall be in English and all dimensions shall be in metric units. Before the commencement of preparation of

fabrication drawings, Contractor shall discuss with The Employer's Representative any specific requirement to be followed for fabrication drawing preparation.

(f) No detailed shop drawings will be accepted by the Engineer unless they are complete and checked and approved by Contractor's qualified structural engineer and accompanied by an erection plan showing the location of all pieces detailed.

(g) Contractor should check for erection clearance and ensure that the detailing of connections is carefully planned to obtain ease in erection of structures including field-welded connection and bolting. Field connections/splices may be welded or bolted type.

(h) Contractor shall submit design calculations for each, and every connection detail proposed by him and for any substitution for members, desired by him and approved by the Engineer. Fabrication drawings not accompanied by calculation for connection details are liable for rejection.

(i) Each lot of drawings sent by Contractor for approval shall contain a limited number of drawings and shall be in an order and manner which follows erection sequence or as required by Engineer based on priorities allocated. Engineer will return one copy of Contractor's drawing marked with Engineer's approval/comments. Contractor shall furnish the Engineer the required number of prints of all approved drawings for field use and record purpose.

(j) Engineer or Engineer's Representative may review / approve the fabrication drawing at his option some, all or none of the fabrication drawings. Wherever such reviews are carried out the same shall be restricted to the following.

(i) Review/ approval of the size of members, dimensions and general arrangement but shall not constitute approval of the connections between members and other details.

(ii) Correctness of overall dimensions centre to centre distance, elevations. Important / typical connection details (adequacy of number of bolts / weld length for few connections only will be checked), working points for bracing members and orientations and sizes / sections of members.

(iii) Sequence of erection in the light of project requirements.

(iv) Whether the fabrication drawings broadly conform to details shown on design drawings and comply with technical specifications, general notes, any specific notes made on design drawings and generally with the requirement of good engineering practice.

k) It shall be clearly noted by the contractor that even where review is done by the Engineer or Engineer's Representative, the following shall be the sole responsibility of the Contractor.

(i) Provision for erection,

(ii) Marking of members,

(iii) Cutting lengths of members,

(iv) Matching of joints and holes,

(v) Provision kept in the member for all other interconnected members,

(vi) Bill of materials,

(vii) Gusset sizes.

(l) Approval by Engineer or Engineer's Representative of any of the fabrication drawings shall not relieve the Contractor from the responsibility for correctness of engineering, design of connections, workmanship, and fit of parts, details, material, errors or omissions of any and all work shown thereon. Engineer's approval shall not invalidate any claim for damages of any kind for incorrectly detailed / fabricated steel, notwithstanding any approval of such drawings by Engineer.

(m) On completion of fabrication and erection, the contractor shall update his fabrication drawings, incorporating all site changes and substitutions and shall submit two (2) sets of hard copies of such "as-built" drawings to The Employer for record purpose. The Contractor shall also furnish two sets of soft copies of all final approved Contractor's drawings in the form of CDs.

(n) Time consumed by the Contractor in securing approval of drawings should not be added to the time allowed for completion of contract. A period of four (4) weeks from the dates of receipt of drawings by the Engineer or Engineer's Representative should be anticipated for this item of procedure in the schedule.

(o) All these drawings submitted by the contractor will remain the property of the Employer. The Employer reserves the right to use them in any manner whatsoever.

(p) The drawings prepared by the Contractor and all subsequent revisions etc. shall be at the cost of the Contractor for which no separate payment will be made.

4.3 FABRICATION

4.3.1 General

(a) Fabrication shall not be started until Contractor has received copies of such drawings upon which Engineer has endorsed his approval. Any work done prior to approval of Contractor's fabrication drawings will be at the Contractor's risk. The Contractor shall make such changes in the design when so directed, which are considered necessary to make the structures conform to the provisions and intent of the specifications, without any additional cost to the Employer.

(b) All workmanship and finish shall be of the best quality and shall conform to good engineering practice and the best approved method of fabrication. All materials shall be finished straight and shall be machined/ ground smooth true and square where so specified.

(c) All holes and edges shall be free of burrs. Shearing and chipping shall be neatly and accurately done, and all portions of work exposed to view shall be neatly finished. Standard fabrication clearances as detailed in the American institute of Steel Construction Manual / BIS Codes shall generally be followed unless otherwise directed/ approved.

(d) Material at the shops shall be kept clean and protected from weather. Cutting

punching, drilling, welding and fabrication tolerances shall be generally as per relevant Codes and Standards. In addition, the Contractor shall strictly adhere to the following.

i) All care should be taken to avoid undue welding distortions

ii) Complete layout shall be prepared and got approved by the Engineer before actual fabrications are started. If needed mock-ups may also be prepared.

iii) All fit ups shall be got approved from the Engineer.

4.3.2 Connections

(a) All shop connections shall be welded unless otherwise specified in Engineer's/ Engineer's Representative's drawing. Field connections can be either welded or bolted and as shown in design drawings. Bolts used for erection shall conform to IS: 6639 and as specified in the design drawings.

(b) All connections shall be designed for forces indicated on the design drawings. The contractor shall be responsible for selection of standard connections from AISC Manual of Steel Construction or any other standards approved by Engineer.

(c) In case of bolted connections, taper washers or flat washers or spring washers shall be used with bolts as necessary. In case of high strength friction grip bolts, hardened washers are used under the nuts or the bolt heads whichever are turned to tighten the bolts. The length of the bolt shall be such that at least one thread of the bolt projects beyond the nut, except in case of high strength friction grip bolts where this projection shall be at least three times the pitch of the thread.

(d) In all cases where bearing is critical, the unthreaded portion of bolt shall bear on the members assembled. A washer of adequate thickness may be provided to exclude the threads from the bearing thickness, if a longer grip bolt must be used for this purpose.

(e) Not more than one shop splice shall be provided to make up the full length of a member. Shop splices to make the full member lengths shall be of full penetration butt welded type and radiographically tested.

(f) Transportation or the Contractor's erection methods may require additional splices not shown on the drawings. The contractor shall be responsible for the design and detailing of such splices or joints and shall submit these for the Engineer's approval.

(g) All bolts, nuts, washers, electrodes, screws etc. shall be supplied/ brought to site 10% in excess of the requirement in each category and size. Rates shall cover the cost of this extra quantity and no additional payment will be made for this extra quantity supplied.

(h) All members likely to collect rainwater shall have drain holes provided.

4.3.3 Straightening

(a) Rolled materials, before being worked, shall be straightened, unless

otherwise specified. If straightening or flattering is necessary, it shall be done by methods that will not injure the material. Long plates shall be straightened by passing through a mandrel or levelling rolls and structural shapes using mechanical or hydraulic bar/ section straightening machines. Heating or forging shall not be resorted to without the prior approval of the Engineer in writing. In case of site fabrication, Contractor shall obtain Engineer's approval in writing on the straightening method proposed to be adopted before commencing the work.

(b) Checking of the straightness of the structural members like angles, channels, beams etc. shall be done by using the thread. For checking of the straightness of the column sections piano wire shall be used. The sections, which are twisted beyond repairs, shall not be used for fabrication. Heating or hammering shall not be permitted. After removal of bends structural members shall be submitted for inspection and approval of Engineer.

4.3.4 Cutting

(a) Cutting may be done by shearing, cropping, sawing or machine flame cutting. All re-entrant corners shall be shaped notch free to a radius of at least 12-mm. Sheared or cropped edges shall be dressed to a neat workmanlike finish and shall be free from distortions and burrs.

(b) Hand flame cutting shall be undertaken, only if so, permitted by the Engineer and shall only be carried out by an expert in such work. Hand flame cut edges shall be ground smooth and straight.

(c) Edges of flange cover plates and plates used to form any sections shall be ground smooth.

4.3.5 Punching and Drilling

(a) Holes in secondary members such as Purlins, grits, lacing bars etc. may be punched full size through material not over 12mm thick. Holes should be clean cut, without burr or ragged edges. Holes for all other connections shall be drilled accurately and the burrs removed effectively. Where several parts are to be connected to very close tolerances, such parts shall be first assembled, tightly clamped together and drilled through.

(b) Sub-punching may be permitted before assembly, provided the holes are punched 3mm smaller in diameter than the required size and reamed after assembly to the full diameter. The thickness of material punched shall not in such cases exceed 16mm.

(c) When match drilling is carried out in one operation through two or more separate parts, these parts shall be separated after drilling and the burrs removed.

(d) Holes for turned and fitted bolts shall be drilled to a slightly smaller diameter and reamed to a diameter equal to the nominal diameter of the shank or barrel subject to tolerance specified in IS: 919.

(e) Where reamed members are taken apart for transporting or handling, the

respective pieces reamed together shall be so marked that they may be reassembled in the same position in the final setting up. No interchange of reamed parts will be permitted. Poor matching, over drilling and ovality in holes shall be a cause for rejection. Burning holes with gas is strictly prohibited.

(f) Holes may be required to be drilled by the Contractor at no extra cost at site for installing equipment or steel furnished by other agencies. The information for this will be supplied to the Contractor by the Engineer before or after erection of the steel. Holes should be by drilling or other machining process and not by gas cutting sets.

4.3.6 Rolling and Forming

Plates, Channels, Rolled Steel Joists etc., for circular bins, bunkers, hoppers, gantry girders, etc., shall be accurately laid off and rolled or formed to required profile/ shape as called for on the drawings. Adjacent sections shall be match-marked to facilitate accurate assembly, welding and erection in the field.

4.3.7 Grinding

Column ends bearing on each other, resting on base plates, compression joints designed for bearing, base plates coming in contact with column end and cap plate shall be ground smooth to ensure 90% contact with local gap not exceeding 0.10 mm (filler gauge shall be used to check this gap). All ground surfaces shall be protected from dirt and mechanical damages till the assembly is completed. However, the underside of base plate bearing on grout need not be machined.

4.3.8 Welding

(a) Before the start of the work, welding procedure shall be submitted to Engineer for approval. Welding shall be entrusted to only qualified and experienced welders who shall be periodically tested and graded as per relevant standards. Approval of the welding procedure by the Engineer shall not relieve the Contractor of his responsibility for correct and sound welding without undue distortion in the finished structure.

(b) Welding Procedure Specification (WPS) shall be established and Qualification of weld procedure (QWP) shall be done as per approved standards. Welders employed shall be qualified as per above standards prior to taking up fabrication. Contractor shall obtain approval from Engineer before the start of the work.

(c) Following pre-qualified welding process shall be employed for fabrication, erection and repair and the same shall have the approval of Engineer before adopting the welding process on the job.

(i) Submerged Arc Welding (SAW)
(ii) Shield Metal Arc Welding (SMAW)
(iii) Gas Metal Arc Welding (GMAW)
(iv) Gas Tungsten Arc Welding (GTAW)

(d) All welds shall be free from defects like blowholes, lack of penetration, undercutting, cracks etc. All welds shall be cleaned of slag or flux and show sections, smoothness of weld metal, featheredges without overlap and freedom from porosity.

(e) 50mm on either side of the surfaces on which weld metals is to be deposited shall be smooth, uniform, free from fins, tears, burrs, cracks and free from grease, paint, loose scale, moisture or any other substance which would adversely affect quality and strength of weld.

(f) Machining, thermal cutting or grinding may be employed for joint preparation or removal of unacceptable work or metal. The weld edges shall be smooth & regular surface, free from cracks & notches. Flame cut material above 50mm thick shall be pre-heated as per relevant standards prior to flame cutting and shall be subjected to Engineer's approval.

(g) All weld fit-up shall comply with tolerances specified in the relevant standards. The parts to be joined by fillet welds shall be brought into close contact as practicable and within the tolerable limits as per relevant codes & standards.

(h) All tack welds shall be made using qualified procedure and qualified welders. Any preheat requirement specified in the welding procedure shall also apply to tack welds. All tack welds shall be examined visually for defects and if found defective, shall be removed and re-welded. Throat thickness, leg length and length of tack weld shall be as per IS: 9595.

(i) Welding of temporary attachments/ fixtures to retain fit up is permitted in case the parts have a nominal thickness of at least 10mm. Temporaryattachments are welded at the minimum distance of at least 50mm from the weld seam. Welding of temporary attachments/ fixtures into the joint slot is not allowed. All temporary fixtures shall be removed after welding, by grinding then to weaken the welded portion and hammering thereafter followed by grinding the portion of any weld remaining on the base metal. A dye check at the discretion of the quality surveyor shall be done to detect any crack/ defect at the point of fixture temporary weld.

(j) It is not allowed to turn over and carry over heavy assemblies in tacking condition in order to control the geometric dimensions to the requirements of the drawings. The work shall be positioned for flat welding wherever practicable and overhead weld shall be avoided as far as possible.

(k) In the joints of the parts with dissimilar thickness smooth transition of one part to the other must be provided by way of the gradual decreasing of the thickness of the thicker part with the slope of the surface not exceeding 15 degree.

(l) Welding shall not be done when the surface of the members is wet or exposed to rain, or high wind velocities unless the welding operator and the work are properly protected.

(m) In joints connected only by fillet welds, the minimum size of fillet weld to be used shall be as per IS: 9595.

(n) Welds shall be defect free and surfaces shall be thoroughly cleaned to remove all visible weld defects and extra material.

(o) For all built up sections such as Columns, Crane Grinders etc welding between web and flange plates shall be carried out by SAW process. Especially for crane girders full penetrations of weld between top of web plate and top flange shall be ensured. Welding shall be continuous and shall be on both sides of the connecting member. One side fillet weld is not acceptable.

(p) While fabricating plated beams and built up members, all shop splices in each component part shall be made before such component part is welded to other parts of the members. Wherever weld reinforcement interferes with proper fit- up between components to be assembled for welding, these welds shall be ground flush prior to assembly.

(q) Each layer of a multiple layer weld except root and surfaces runs may be moderately peened with light blows from a blunt tool. Care shall be exercised to prevent scaling or flaking of weld and base metal from overpeering.

(r) No welding shall be done on base metal at a temperature below -5 Deck. Base metal shall be preheated to the temperature as per relevant IS codes.

(s) In general, all welding shall be performed as per the recommendations specified in IS: 9595.

(t) Pre-heating and Post weld Heat treatment shall be carried out as per the acceptable standards and procedure and shall have prior approval from the Engineer. The pre-heat and inter pass temperature shall be checked just prior to initiating the arc for each pass. The weld joint details and procedure for Pre-heating and Post heating shall be submitted by the Contractor for approval from Engineer.

4.3.9 Welding Consumables

(a) Electrodes, filler wires and flux used for welding shall be from approved manufacturers/ Suppliers. Contractor shall submit the list of Electrode manufacturers proposed to be procured to the Engineer for approval. The contractor shall furnish certification that electrode or electrode flux combination will meet the requirements of classification. The classification and size of electrode, arc length, voltage & amperage shall be suited to type and thickness of material, type of groove, welding positions and other circumstances attending work.

(b) Only low hydrogen electrodes shall be used for welding. All electrodes having low hydrogen covering shall conform to relevant acceptable standards. These electrodes shall be purchased in hermetically sealed containers or baked by the user as recommended by electrode manufacturer. Electrode flux coating shall be sound and unbroken. Broken or damaged coating shall cause the electrodes to be discarded. Before welding, the electrodes shall be dried in a holding oven at 120°C at least for one (1) hour or as per manufacturer's recommendations. Only limited quantity shall be issued to the welders. The electrodes shall be kept in "carry ovens" and shall not be exposed to the atmosphere.

(c) Welding plants and accessories shall have capacity adequate for welding

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procedure laid down and shall satisfy appropriate standards and be of approved make and quality. Contractor shall furnish and obtain approval from Engineer the details of equipment he proposes to deploy for the works. All the electrical plant in connection with the welding operation shall be properly and adequately earthed and adequate means of measuring the current shall be provided. Proper safety rules shall be strictly followed.

4.4 TESTING, INSPECTION & REPORTS

4.4.1 General

(a) Contractor shall give due notice to The Employer/ The Employer's Representative in advance of the materials or workmanship getting ready for inspection. All rejected material shall be promptly removed from the shop and replaced with new material for the Engineer/ Engineer's Representative's approval/ inspection. The fact that certain material has been accepted at Contractor's shop shall not invalidate final rejection at site by the Engineer/ Engineer's Representative, if it fails to conform to the requirements of these specifications, be in proper condition or has fabrication inaccuracies which prevents proper assembly nor shall it invalidate any claim which the Engineer/ Engineer's Representative may make because of defective or unsatisfactory materials and/or workmanship.

(b) No materials shall be painted or dispatched to site without the inspection and approval by the Engineer/ Engineer's Representative unless such inspection is waived in writing by the Engineer/ Engineer's Representative.

(c) Shop inspection by Engineer/ Engineer's Representative or submission of test certificates and acceptance thereof by Engineer/ Engineer's Representative shall not relieve Contractor from the responsibility of furnishing material conforming to the requirements of these specifications, nor shall it invalidate any claim which the Engineer/ Engineer's Representative may make because of defective or unsatisfactory material or workmanship.

(d) Contractor shall provide all the testing and inspection services and facilities for shop work except where otherwise specified. Contractor's inspection work shall be under the control of competent Chief Inspector whose primary responsibility is inspection (reporting to Management) and not to production department.

(e) High Strength Friction Grip Bolting: Inspection after tightening of bolts shall be carried out as stipulated in the appropriate standards depending upon the method of tightening and the type of bolt used.

(f) For fabrication work carried out in the field, the same standard of supervision and quality control shall be maintained as in shop fabricated work. Inspection and testing shall be conducted in a manner satisfactory to the Engineer/ Engineer's Representative. Inspection and tests on structural steel members shall be as set forth below:

4.4.2 Material Testing

(a) All materials conforming to an Indian or any other standard as called for shall be tested as required by such standard. Proof in the form of certified test reports or mill certificates indicating the required tests have been carried out as per specification at the source is acceptable.

(b) If mill test reports are not available for any steel materials, the same shall be got tested by Contractor to Engineer's/ Engineer's Representative's satisfaction to demonstrate conformity with the relevant specification at his own cost.

(c) Raw material with cracks, seams, laps, lamination and heavy pitting are not acceptable. Ultrasonic testing of plates above 50 mm thick shall be carried out for the soundness of materials.

(d) Engineer has option to specify additional inspection or testing as he deems necessary and the additional cost of such testing shall be borne by the Contractor.

(e) The Contractor shall maintain records of all inspection and tests, which shall be made freely available to the Engineer/ Engineer's Representative and shall be submitted to the Engineer/ Engineer's Representative on completion of each stage of work.

4.4.3 Tests on Welds

(a) All welds shall be tested for flaws by any of the methods described under. The choice of the method adopted shall be determined by the Engineer/ Engineer's Representative. Following methods are generally recommended for the quality control of welded joints.

(b) Magnetic Particle Test (MPT): All fillet welds in general structural steel work shall have their final passes fully tested by MPT. However, for fillet welds of size 10mm and above and/or critical areas, the root and final passes shall be tested using MPT. The Engineer shall however decide the requirements of this additional testing. For Complete penetration butt welds, the root and final passes shall be tested using MPT. All MPT shall be as per relevant acceptable standards. Defects if found, shall be repaired and retested. MPT shall be carried out using alternating current only. Direct current may be used with the permission of the ENGINEER. The cost of demagnetizing after testing is deemed to be included in the quoted rates of the Contractor.

(c) Liquid Penetrant Test (LPT): MPT may be substituted by Liquid Penetrant Inspection where the former is not feasible due to configuration. The testing should be in accordance with relevant acceptable standards. All defects shown shall be repaired and rechecked.

(d) Radio-graphic Inspection (RT): All completed full penetration butt welds shall be fully or selectively (say 10%) shall be radio-graphed as per Engineer's directive in accordance with the relevant acceptable standards.

(e) Ultrasonic Testing (UT): Wherever built up sections for crane runways girders are fabricated, the T-joints of the sections shall be subjected to ultrasonic

testing.

(f) Acceptance Standard: The acceptable standards for various weld tests shall be as per ASME Sec VIII- Div. I or relevant acceptable standards.

4.4.4 Inspection of Welds

(a) Welding shall be carried out as per approved WPS and QWS by qualified welders.

(b) The correction of defective welds shall be carried out as directed by the Engineer without damaging the parent metal. When a crack in the weld is removed, magnetic particle inspection or any other equally positive means as prescribed by the Engineer shall be used to ensure that the whole of the crack and material up to 25mm beyond each end of the crack has been removed. Cost of all such tests and operations incidental to correction shall be to the Contractor's account.

(c) Contractor shall perform the following minimum tests on welds with no cost implication to The Employer. Contractor's quoted rate is deemed to have included the cost of such tests.

Sl.NO :	Location & Type of Weld	Type of Test	Extent of Test	Remarks
1	All fillet welds in general other than those covered under the Sl. No: 2, 3, 5, 7 & 8	LPT	1% of fillet weld with minimum of one test on each	
2	Fillet welds for plate thickness greater than 25 mm and fillet size more than 10 mm	MPT/DPT	10%	
3	Flame cut edges of plates more than 38 mm for fillet weld	MPT/LPT	100%	
4	Flame cut edges of plates greater than 25 mm for butt weld	MPT/LPT	100%	
5	Fillet welds between tension flanges and webs	MPT/LPT	100%	

6	Full penetration butt welds	DPT	100%	DPT shall be carried out after back gouging before second side welding.
7	Fillet weld greater than 12 mm on flame cut edges of low alloy steel	MPT	100%	
8	Fillet welds for built up girders, columns and other heavy structures for penetration	Macro etches	One (1) test per structure for penetration	
9	Butt welds of thickness greater than 25 mm and less than 32 mm	MPT/DPT	100%	
10	Butt welds of thickness greater than 32 mm	RT	100%	
11	Butt welds of rolled sections having depth greater than 600 mm	RT	100%	

(d) In addition to the minimum tests to be conducted by the Contractor, Engineer reserves his right to direct the Contractor to conduct additional tests. The

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extent, type and location of test shall be decided by the Engineer. These additional tests shall be conducted by the Contractor or through an approved agency in presence of the Engineer. If the test fails, the cost of that test shall not be payable to the Contractor. The tests which when successful will be paid for at the rates specified in the schedule.

(e) Weld defects and acceptable criteria

Type of defect	Acceptance criteria	Remarks
Cracks	Not acceptable	
Incompleteor lac of fusion k	Not acceptable	
Misalignmen o f b u t tt welds	0.25 x T (Maximum of 3mm)	T: thickness of thinner plate
Reinforcemen t	Max reinforcement of 2 mm for t <10 mm 3 mm for t >10 mm < 15mm 4 mm for 15 mm andgreater	
Undercut	0.25 mm deep max	
Sharp edges	Min radius of 2mm	

f) Weld repairs

Whenever weld repair is required, Contractor shall give prior intimation to the Engineer and obtain permission before the repair is taken up. When a defect is detected in a weld, it shall be removed by cutting/ grinding and smooth blending of the area with parent metal without sharp edges, corners. If welding is required, the same shall be done using the qualified procedure/ welder and stage inspection as per the original weld. Correction of defect in the same portion of the weld shall not be allowed more than two (2) times. The portion of the welding seams, which have been subjected to repair, must

be indicated in the weld inspection reports.

4.4.5 **Inspection and Tests on Structural Steel Fabricated Members**

Inspection and tests on Structural Steel Fabricated Members shall be as set forth below:

a) All the fabricated parts of Structural Steel members shall be inspected at all stages of fabrication and assembly to verify that dimensions, tolerances, alignment and surface finish are in accordance with the requirements shown on the approved Contractor's shop drawings and/or Engineer's drawings.

b) Fit ups shall be examined by the quality surveyor as per the approved QA plan prior to welding the joint. All welds shall be inspected for flaws by the method described under "Inspection of welds".

c) The dimensions of the fit ups shall be maintained as specified in the fabrication drawings.

d) Dimensions of all assembles and sub-assemblies shall be as per fabrication drawings within the tolerances specified in IS: 7215.

4.5 TEST FAILURE

4.5.1 In the event of any failure of welding, structural steel members to meet inspection or test requirements, the Contractor shall notify The Employer or his authorized representative. A design concession request must be made and got approved from the Engineer or his representative before repair is undertaken. The quality control procedures to be followed to ensure satisfactory repair shall be subject toapproval by the Engineer.

4.5.2 Contractor shall maintain records of all inspection and testing which shall be made available to the Engineer or his authorized representative, for three years from the date of completion of the contract.

4.5.3 The Engineer has the right to specify additional testing as he deems necessary, and the additional cost of such testing shall be borne by The Employer, only in case of successful testing.

4.6 TOLERANCES

The dimensional and weight tolerance for rolled shapes shall be in accordance with IS: 1852 for indigenous steel and equivalent applicable codes for imported steel. The tolerances for fabrication of structural steel shall be as per IS: 7215.

4.7 SHOP MATCHING

For structures like bunkers, tanks, etc. shop assembly is essential. For other steel work, such as columns along with the tie beams/ bracings may have to be shop assembled to ensure satisfactory fabrication, obtaining of adequate bearing areas etc., if so desired by The Employer or his authorized representative. All these shop assemblies shall be carried out by Contractor at no extra cost to The

Employer.

4.8 DRILLING HOLES FOR OTHER WORKS

As a part of this Contract, holes in members required for installing equipment or steel furnished by other manufacturers or other contractors shall be drilled by the Contractor at no extra cost to The Employer. The information for such extra holes will be supplied by The Employer or his authorized representative.

4.9 MARKING OF MEMBERS

4.9.1 After checking and inspection, all members shall be marked for identification during erection. This mark shall correspond to distinguishing marks on approved erection drawings and shall be legibly painted and stamped on it. The erection mark shall be stamped with a metal dye with figures at least 20 mm high and to such optimum depth as to be clearly visible.

4.9.2 All erection marks shall be on the outer surface of all sections and near one end, but clear of bolt holes. The marking shall be so stamped that they are easily discernible when sorting out members. The stamped marking shall be encircled boldly by a distinguishable paint to facilitate easy location.

4.9.3 Erection marks on like pieces shall be in identical locations. Members having lengths of 7.0 m or more shall have the erection mark at both ends.

4.10 ERRORS

Any error in shop fabrication which prevents proper assembling and fitting up ofparts in the field by moderate use of drift pins or moderate amount of reaming willbe classified by The Employer or his authorized representative as defective workmanship. In case The Employer or his authorized representative rejects such material or defective workmanship, the same shall be replaced by the materials and workmanship conforming to The Employer or his authorized representative's requirements by Contractor free of cost at site.

4.11 SHOP PAINTING

Surface preparation and painting of steel surfaces shall be in accordance with specifications provided in **Clause 8.0**. All surfaces inaccessible after erection shall receive two coats of the approved paint before erection. All fabricated steel material, except those galvanized shall receive protective paint coating as specified in **Clause 8.0** of this specification. Galvanizing of fabricated steel wherever specified, shall be as per approved detailed specification.

4.12 QUALITY SURVEILLANCE

4.12.1 General

(a) The Engineer shall subject all works and materials covered by this specification to Inspection.

(b) The Contractor shall provide free access in his shop during working hours for the inspection staff, designated by the Engineer, at all phases of the work and assist them where necessary in conducting the inspection. The Contractor shall expeditiously furnish all gauges, instruments and other necessary measuring equipment required for inspection of the work in the shop. The shop inspection by the inspector is intended to ensure that the material and the workmanship are in accordance with this specification, but it will be not relieving the Contractor of any of his responsibilities for the product. The inspector's inspection will include, but not be limited to, the following:

4.12.2 Material

The inspector will ascertain that only materials conforming to the requirements ofthis specification are used.

4.12.3 Dimension and Tolerance

(a) The Engineer will ensure and check that the structural members conform to the dimensions and tolerances as set out on the drawings and as required by the specification.

(b) Members shall be inspected at all stages of fabrication and assembly to verify that dimensions, tolerances, alignment, surface finish and painting are in accordance with the requirements shown in the Contractor's approved fabrication drawings and The Employer's requirements.

4.12.4 Welding Procedure

The Engineer will witness the welding and testing of any procedure qualification tests that are required by this specification. The Engineer will also check that welding procedure (including the electrode, flux, current, arc voltage, speed of travel) used are in accordance with the approved welding procedures.

4.12.5 Welding Equipment

The Engineer will check the welding equipment to be used for the work to ensure that it is in such condition as to enable qualified welders to follow the procedures.

4.12.6 Welder & Welding Operator Qualifications

(a) The Engineer will permit welding to be performed only by welders and welding operators who are qualified by tests in accordance with relevant standards.

(b) When the quality of a welder or welding operators work, appears to be below the requirements, the Engineer may require testing of his qualifications by necessary tests.

4.12.7 Welds

(a) The Engineer will ascertain that the sizes, length and the location of all welds

conform to the requirements of this specification and the approved fabrication drawings. Temporary welds used for the works shall be removed and ground flush with the original surface.

(b) The Engineer will identify with a distinguishing mark of all parts of the joints that he has inspected and accepted.

(c) The Contractor shall comply with all the demands of the Engineer to correct improper workmanship and to remove and replace, or correct as instructed, all welds found defective or deficient.

(d) In the event of faulty welding or its removal for rewelding results in damage to the base metal in the judgment of the Engineer, or its retention is not in accordance with the intent of the plans and specification, the Contractor shall remove and replace the damaged material at his own cost.

5.0 ERECTION OF STRUCTURAL STEEL

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5.8 FIELD CONNECTIONS

5.9 INSPECTION

5.10 TOLERANCES

5.11 PAINTING

This specification covers the general requirements for erection of structural steel. In addition to provision of erection and transport equipment, the scope of work includes supply of tools and tackles, consumables, materials, labor and supervision and shall cover the following:

(a) Storing and staking of all fabricated structural components/ units/ assemblies at site storage yards till the time of erection.

(b) Transportation of structures from storage yard to site of erection, including multiple handling, if required.

(c) All minor rectifications/ modifications such as, removal of bends, kinks, twists etc for parts damaged during transportation and handling, reaming of holes which do not fit properly or which are damaged, for use of next higher size bolt, plug-welding and re-drilling of holes which do not register and which cannot be reamed for use of next higher size bolt, drilling of holes which are either not drilled at all or are drilled in incorrect position during fabrication.

(d) Fabrication of minor missing items as directed by The Employer or his authorized representative.

(e) Verification of the position of embedded anchor bolts and inserts with respect to lines and levels, installed by others based on Geodetic Scheme/ Benchmark/ Reference co-ordinates to be furnished by The Employer or his authorized representative.

(f) Verification of actual dimensions of structures (erected by others) which would have bearing on the cutting lengths, end connections etc of those members which are to be erected under this scope of work.

(g) Assembly of steel structural components at site wherever required, including temporary supports and staging.

(h) Erection of structures including making connections by bolts/ High strength Friction Grip bolts/ welding as per drawing.

(i) Alignment of all structures true to line, plumb and dimensions within specified limits of tolerance.

(j) Deciding for providing all facilities for conducting Ultrasonic Testing (UT) by reputed testing laboratories approved by The Employer or his authorized representative and making available test films / graphs, with reports / interpretation.

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(k) Rectifying at site, damaged portions of shop primer by cleaning and application of touch-up paint. Application at site after erection required number of coats of primer and finishing paint as per specification.

(l) Rectification of structures as per preliminary acceptance report and Final acceptance report.

(m) All necessary items of work required for satisfactory completion of job on schedule.

5.1 ERECTION SCHEME

5.1.1 Contractor after the award of work shall submit a detailed erection scheme covering the period of completion of all the works covered under the specification for The Employer or his authorized representative's approval. The erection scheme shall include but not limited to the following.

(a) Methods proposed to be employed for transporting his equipment's, tools, tackles, gas cylinders, electrodes and all that is necessary to site.

(b) Type, capacity and quantity of equipment that the Contractor proposes to bring to site for unloading, transporting within the site, handling, assembling, hoisting and erecting of the structural steel components for all these operations.

(c) Strength and trade wise composition of the work force and supervisory personnel that will be deployed by the Contractor for the various operations.

(d) Any special specific scheme being adopted for erection of special / complicated structural elements.

5.1.2 A brief write-up covering the above activities shall be submitted along with the bid document by the bidder during submission of his bid.

5.1.3 Engineer reserves the right to direct the Contractor either at the start or during the contract period, to mobilize additional resources in terms of labour, material equipment, tools and plant etc. at no cost to The Employer if in his opinion that the resources employed by the Contractor does not meet the schedule of completion.

5.2 ERECTION PROGRAMME

5.2.1 Within two (2) weeks of acceptance of bid, the Contractor shall submit a detailed erection programme with dates and estimated completion time for various parts of the work for Engineer's approval. This programme shall broadly comprise the following:

(a) Layout plan identifying the areas proposed for unloading, main storage, subsidiary storage and assembly.

(b) Transportation of fabricated material between the storage and work areas.

(c) Layout to indicate the points at which proposed erection begins, direction in which it is proposed to progress, the deployment of equipment, access route for cranes to reach work areas, etc.

(d) The locations and extent of site offices and stores, labor quarters if any.
(e) Layout of electrical cables and water pipes from the tap-off points.
(f) Details of the method of handling, transport, hoisting and erection including false work/ staging, temporary bracing, guying, etc. along with complete details of the quantity and capacity of the various items of erection equipment that will be used.
(g) Site organization chart showing the number of supervisory personnel, and the number and composition of the various gangs.

5.2.2 Any modifications to the erection programme directed by Engineer for reasons ofinadequacy of

(a) The quantity and/or capacity of the erection equipment.
(b) Erection personnel and supervisors, temporary bracing, guying etc.
(c) Safety of the erection methods, or stability of the erected portions of structures, or unsuitability of the erection sequence due to interference with the work of other agencies.
(d) Any other unforeseen events which may delay the schedule. shall be incorporated by Contractor and the work shall be carried out in accordance with the revised programme. Approval by Engineer shall not relieve the Contractor from the responsibility for the safe, sound, accurate and timely erection of structural steel work as required by the Engineer/ The Employer. Contractor shall also make no extra claims for bringing additional equipment to site for erection, if so, directed by Engineer. Contractor shall be deemed to have visualized all erection problems while bidding for the work and no additional compensation shall be claimed on this account.

5.3 SITE OPERATIONS

5.3.1 Contractor shall employ an experienced and qualified Engineer who shall be in full time charge of the job and responsible for all site activities.

5.3.2 Contractor shall complete all preliminary works at site well before the arrival of structural steel, such as establishment of a well-equipped and adequately staffed site office, stores, unloading gantry, unloading and pre-assembly yard, labour quarters if any, electrical and water connections, electrical winches, derricks, cranes, compressors, all tools and tackles, rivet guns, welding sets, torque wrenches, spud wrenches, staging, etc. as well as experienced erection and supervisory personnel as part of this contract and any other work that may be necessary so as to start erection immediately after the arrival of the first batch ofsteel at site.

5.3.3 Contractor shall furnish at his own expense, the necessary non-inflammable staging and hoisting materials or equipment required for the erection work and shall remove and take them away after completion of the job. Contractor shall also provide necessary passageways, fences, safety belts, helmets, lights and other fittings to the satisfaction of The Employer / Engineer and to meet the rules of local authorities and for protection to his men and materials. A licensed electrician shall be kept on the job for the entire duration of the work to maintain

Contractor's electrical equipment and connections.

5.3.4 Contractor shall protect all existing plant, structures, piping, conduits, equipment and facilities against damage during erection. Any damage caused by Contractor shall be rectified entirely at Contractor's cost, to the satisfaction of The Employer / Engineer. If work must be carried out adjacent to existing switch yards or electrical installations which are live, Contractor must ensure suitable safety precautions in consultation with Engineer.

5.3.5 If a portion of the work of the project area cannot be made available to Contractor for his activities due to operations being carried out by other agencies, he shall suitably modify his sequence of operations to continue work without interruption. Contractor shall work in coordination with other agencies working on the project site and plan his work suitably so as not to hinder the progress of construction atsite.

5.4 ACCEPTANCE OF STEEL, ITS HANDLING & STORAGE

5.4.1 The fabricated material received at erection site shall be verified with respect ofmarking on the key plan / marking plan or shipping list.

5.4.2 Any material found damaged or defective shall be stacked separately and the damaged or defective material shall be painted in distinct color for identification and the same shall be brought to the notice of Engineer.

5.4.3 No dragging of steel shall be permitted. All fabricated items shall be stored 300mm above ground on suitable packing to avoid damage. It shall be stored in the order required for erection, with erection marks visible. All storage areas shall be prepared and maintained by Contractor. Steel shall not be stored in the vicinity ofareas where excavation or grading will be done and, if so, stored temporarily, thisshall be removed by Contractor well before such excavation and/or grading commences to a safe distance to avoid burial under debris.

5.4.4 Scratched or abraded steel shall be given a coat of primer in accordance with the specification after unloading and handling prior to erection. All milled and machined surfaces shall be properly protected from rust/corrosion by suitable coating and from getting damaged.

5.5 ANCHOR BOLTS, EMBEDDED PARTS & FOUNDATIONS

5.5.1 Contractor shall carefully check the location and layout of anchor bolts embedded in foundations constructed by others, to ensure that the structures can be properly erected as shown on the drawings. Any discrepancy in the anchor bolts/foundation shall be reported to Engineer.

5.5.2 Contractor shall carefully check the actual dimensions of structures and the location, level and sizes of embedded parts, a) in the RC beam /column and/ or b) cleats / plates provided in steel beam /column constructed by others to receive structures covered under this scope of work. Contractor shall take note of discrepancies if any, shall be reported to Engineer and fabricate the structures covered under this contract suitably before the commencement of erection.

5.5.3 Levelling of column bases to the required elevation may be done either by providing shims or three nuts on the upper threaded portion of the anchor bolt. All shim stock required for keeping the specified thickness of grout and in connection with erection of structures on foundations, crane brackets or at any other locations shall be of good M.S. plates and shall be supplied by Contractor at his cost.

5.5.4 A certain amount of cleaning of foundations and preparing the area is considered normal and shall be carried out by Contractor at no extra cost.

5.5.5 Where beams bear in pockets or on walls, bearing plates shall be set and levelled as part of the work. All grouting under column base plates or beam bearing plates will be carried out by Contractor, unless the grouting is specifically excluded from the Contractor's scope.

5.6 ASSEMBLY & CONNECTIONS

5.6.1 Field connections may be affected either by bolting, welding or by use of high strength friction grip bolts as shown in the design and erection drawings.

5.6.2 All bolts, nuts, washers, rivets, electrodes required for field connections shall be supplied by Contractor free of cost. The materials shall have prior approval from The Employer /Engineer and necessary test certificates shall be furnished to Engineer's approval. Materials shall be procured from the reputed manufacturers with prior approval from The Employer /Engineer

5.6.3 All assembling shall be carried out on a level platform.

5.6.4 Drifts shall be used only for drawing the work to proper position and must not be used to such an extent as to damage the holes. Size of drifts larger than the nominal diameter of hole shall not be used. Any damaged holes or burrs must be rectified to the satisfaction of Engineer.

5.6.5 Corrections of minor misfits and reasonable amount of reaming shall be considered as a part of erection. Any error in the shop, which prevents proper fiton a moderate amount of reaming and slight chipping or cutting, shall be immediately reported to Engineer.

5.7 ERECTION

5.7.1 Erection work shall be taken up after receipt of clearance from the Engineer.

5.7.2 Erection shall be carried out with the help of maximum mechanization possible.

5.7.3 Prior to commencement of erection, all the erection equipment, tools, tackles, ropes etc shall be tested for their load carrying capacity. Such tests may be repeated at intermediate stages also if considered necessary. Frequent visual inspection shall be done of all vulnerable areas and components to detect damages or distress in the erection equipment's, if any.

5.7.4 All structural steel shall be erected as per approved Design / fabrication drawings. Proper size steel cable slings, etc., shall be used for hoisting. Guys shall not be anchored to existing structures, foundations, etc. unless so permitted by Engineer in writing. Care shall be taken to see that ropes in use are always in good condition.

5.7.5 For safety requirements during erection, provisions of IS: 7205, IS: 7969 and other relevant codes shall be strictly followed.

5.7.6 Steel columns, if any, are to be lowered and erected carefully with the help of acrane and/or derrick without damaging the walls steel or floor.

5.7.7 Structural steel frames shall be erected plumb and true. Frames shall be lifted atsuch points that they are not liable to buckle and deform. Trusses shall be liftedonly at node points. In the case of trusses, roof girders, all the purlins and wind bracing shall be placed simultaneously, and the columns shall be erected truly plumb on screed bars over the pedestals. All steel columns and beams shall bechecked for plumb and level individually before and after connections are made.

5.7.8 Temporary bracing, whenever required, shall be provided to sustain forces due to erection loads and equipment etc. Erected parts of the structure shall remain stable during all stages of erection when subjected to action of wind, dead weight and erection forces etc. Such bracings shall be left in place if may be required for safety and stability. Specified sequence of erection of vertical and horizontal structural members shall be followed

5.7.9 Erected members shall be held securely in place by bolts to take care of dead load, wind / seismic load and erection load.

5.7.10 All structural members shall be erected with erection marks in the same relative position as shown in the appropriate erection and shop drawings.

5.7.11 All connections shall achieve free expansion and contraction of structures wherever provided.

5.7.12 No final bolting or welding of joints shall be done until the structure has been properly aligned and approved by Engineer.

5.7.13 For positioning beams, columns and other steel members, the use of steel sledges is not permitted.

5.7.14 Instrumental checking of correctness of initial setting out of structures and adjustment of alignment shall be carried out in sequence and at different stages as required. The final levelling and alignment shall be carried out immediately after completion of each section of a building.

5.7.15 The Contractor shall design, manufacture, erect and provide false work, staging temporary support etc., required for safe and accurate erection of structural steelwork and fully responsible for the adequacy of the same.

5.7.16 The Contractor shall also provide facilities such as adequate temporary access ladders, gangways, tools & tackles, instruments etc. to The Employer for his inspection at any stage during erection.

5.7.17 Chequered plates shall be fixed to supporting members by welding or by countersunk bolts as shown/ specified in relevant drawings and/or as directed byEngineer. The edges shall be made smooth and no burrs or jagged ends shall beleft. While splicing, care should be taken so that there is continuity in pattern between the two portions. Care should also be taken to avoid distortion of the plate while welding. The erection of chequered plates shall include:

(a) Welding of stiffening angles/ vertical stiffening ribs as per drawings.

(b) Cutting to size and making holes to required shape wherever necessary to allow service lines such as piping, cables etc to pass through,
(c) Splicing as shown in relevant drawings,
(d) Smoothening of edges,
(e) Fixing of chequered plates by welding and/or countersunk bolts,
(f) Providing lifting hooks for ease of lifting.

5.7.18 Cutting, heating or enlarging holes may be carried out only with prior written approval from the Engineer.

5.7.19 Test certificates as specified in Data Sheet A shall be furnished by CONTRACTOR.

5.8 FIELD CONNECTIONS

5.8.1 Assembly by Permanent Bolts:

(a) The number of washers on permanent bolts shall not be more than two (2) and not less than one (1) for the nuts and one (1) for the bolt head.

(b) Only wooden rams or mallet shall be used in forcing members into position in order to protect the metal from injury or shock.

(c) Where bolting is specified on the drawing, the bolts shall be tightened to the maximum limit. The threaded portion of each bolt shall project through the nut by at least one thread. Tapered washers shall be provided for all heads and nuts to achieve uniform bearing on sloping surface.

(d) To prevent loosening of nuts, spring washers or locknuts shall be provided as specified in the design / shop drawings.

(e) All machine fitted bolts shall be perfectly tight and the ends shall be checked to prevent nuts from becoming loose. No unfilled holes shall be left in any part of the structure.

5.8.2 Assembly by Welding:

(a) All field assembly by welding shall be executed in accordance with the requirements for shop fabrication. Where the steel has been delivered painted, the paint shall be removed before field welding for a distance of at least 50 mm on either side of the joints to be welded.

(b) All other requirements of welding and its acceptance standards shall be in accordance with clauses specified in Section-5 above.

5.8.3 Assembly by High Strength Friction Grip Bolts (HSFG Bolts):

(a) Assembly of structures with HSFG bolts shall conform to IS: 4000.
(b) The mating surface shall be prepared in accordance with the requirements of design in order to achieve required properties to develop adequate friction between the surfaces.
(c) The mating surfaces shall be free from grease, lubricant, dust, rust etc and shall be thoroughly cleaned before assembly.
(d) The nuts shall be tightened up to the specific torque with the help of torque-wrench or by half-turn method with the help of pneumatic wrench/lever.

(e) The direction of tightening of the nuts shall be from the middle towards the periphery of assembly.

(f) After desired tightening the bolt heads, nuts and edges of the mating surfaces shall be sealed with a coat of paint to obviate entry of moisture.

5.9 INSPECTION

Engineer or their authorized representatives shall have free access to all parts ofthe job during erection and all erection shall be subjected to their approval. In case of faulty erection, all dismantling and re-erection required will be at Contractor's cost. No paint shall be applied to rivet heads or field welds or bolts until these have been approved by Engineer.

5.10 TOLERANCES

Tolerances mentioned below shall be achieved after the entire structure or part thereof is in line, level and plumb. The tolerances specified below do not apply tosteel structures where the deviations from true position are intimately linked withand directly influence technological process. In such cases, the tolerances on erected steel structures shall be as per recommendations of process technologists/ suppliers which will be indicated in the drawings.

5.11 PAINTING

After steel has been erected, all bare and abraded spots, field welds, bolt heads and nuts shall be spot painted. Before paint is applied, the surface shall be dry and free from dust, dirt, scale and grease. Surface preparation and painting of steel surfaces shall be in accordance with specifications provided in **section 8.0**.

6.0 CLEAN UP OF WORK SITE

During erection, the Contractor shall without any additional payment, always keep the working and storage areas used by him, free from accumulation of waste materials or rubbish. Before completion of erection, he shall remove or dispose of in a satisfactory manner all temporary structures, waste and debris and leave the premises in a condition satisfactory to The Employer/ Engineer.
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7.0 CLEAN UP OF WORK SITE

7.1.1 This specification covers the general requirements for shop and field painting for Structural Steel works using hot/ cold rolled steel sections joined by using bolting and/or welding.

7.1.2 Briefly the scope of works covered under this specification are;

(a) Supply of all primers, paints and all other materials required for painting other than The Employer's supply.

(b) Furnishing of all labor, materials, tools & equipment and the performance of all operations and incidentals necessary for surface preparation, painting, handling, storing, transporting, scaffolding etc.

(c) Testing of paints as per the relevant codes in the Standard Laboratory identified by The Employer and furnishing of required test certificates for approval.

(d) Repair work of damaged / pre-erection / fabrication shop primer and weld joints at field.

(e) Inspection of painting system after its application to conform to the specification requirement.

(f) Any other requirement as required for satisfactory completion of specified work.

8.2 EXCLUSIONS

This specification excludes paintings of the following structures/ equipment,

8.2.1 Mechanical & electrical equipment and parts.

8.2.2 Buried & Overhead piping works

8.2.3 Storage tanks

8.2.4 Insulated parts

8.2.5 Any other items of work specifically excluded in the scope of works.

8.3 APPLICABLE CODES, STANDARDS

8.3.1 The pertinent clauses of the following Indian / International Codes, Standards and Specification (latest editions including all applicable official amendments, reaffirmations and revisions) shall apply to the material and workmanship covered by this specification. In the event of the conflict of certain requirements between this specification and the codes referred herein, this specification shall govern.

8.3.2 It is not the intent to specify herein all the codes and standards required for the satisfactory completion of work. The list of codes and standards indicates certain primary codes & standards and not all the codes required for the work under the contract. It is understood that all the pertinent codes and standards shall form the part of this specification whether explicitly indicated or not.

INDIAN STANDARD CODES:

IS:5 Colour for ready mixed paints and Enamels.

IS:101 Methods of sampling and test for paints, varnishes and relatedproducts (all parts & all sections).

IS:104 Ready mixed paint, brushing, zinc chrome, priming.

IS: 110 Ready Mixed paint, brushing, grey filler for enamels for use over primers.

IS:158 Ready Mixed paint, Brushing, Bituminous, Black, lead free, Acid, Alkali and heat resisting.

IS: 159 Ready Mixed paint, Brushing, Acid resisting.IS: 341 Black Japan, Types A, B and C.

IS:1303 Glossary of Terms relating to paints.

IS:1477 Code of practice for painting of ferrous metals in Buildings (Parts 1 &2).
IS: 2074 Ready Mixed paints, Red Oxide Zinc chrome priming.
IS: 2339 Aluminum paint for general purposes, in Dual container.
IS:2932 Specification for Enamel, synthetic, exterior, type 1:
(a) Undercoating (b) Finishing.
IS:2933 Specification for Enamel, synthetic, exterior, type 2:
(a) Undercoating (b) Finishing.
IS: 5905 Sprayed aluminum and zinc coatings on Iron and Steel. IS: 6005 Code of practice for phosphating of Iron and Steel.
IS: 9862 Specification for ready mixed paint, brushing, bituminous, black, lead free, acid, alkali, water & chlorine resisting.
IS: 9954 Pictorial Surface Preparation Standards for Painting of Steel Surfaces.
IS:13183 Aluminum paint, Heat resistant specification.
IS: 13607 Ready Mixed paint, Finishing, general purposes, to Syntheticspecification.

INTERNATIONAL STANDARD CODES:

SIS-05-5900 Swedish Standard.
SSPC Society for Protective Coatings (USA) Vol I & II.
NACE National Association of Corrosion Engineers, USA (NACE).
ISO 8501 Preparation of Steel Substrates before application of paints and related products -Visual assessment of surface cleanliness (Part 1 & 2).
ISO 8502 Preparation of Steel Substrates before application of paints and related products -Tests for assessment of surface cleanliness (Part 1 to 4).
ISO 8503 Preparation of Steel Substrates before application of paints and related products - Surface roughness characteristics of blast-cleaned steel substrates (Part 1 & 2).
ISO 8504 Preparation of Steel Substrates before application of paints and related products -Surface preparation methods (Part 1 to 3).
ISO 12944 Paints & Varnishes - Corrosion Protection of Steel Structures by ProtectivePaint System.

8.4 HEALTH, SAFETY AND REGULATORY REQUIREMENTS

8.4.1 The work covered in this specification, shall comply with all relevant government and local laws, regulations and standards. For subjects not covered by regulations, codes, standards or specifications, the materials and construction shall be based on good engineering practice, subject to approval by The Employer.

8.4.2 Contractor shall ensure that all health and safety regulations are observed for the erection of scaffolding and use of the selected paint material.

8.4.3 All necessary precautions shall be taken to ensure the safety of personal and property. Extreme caution shall be used when working with oil or oil-based paints, cleaning fluids etc., especially near oxygen piping or oxygen equipment. Heavy

concentrations of volatile or toxic fumes must be avoided and in confined areas, blowers or exhaust fans shall be used.

8.4.4 Rags and other waste material soiled with paints, thinners or solvents shall be kept in tightly closed metal containers while on the jobsite and not in use. Legal disposal of waste materials outside plant site premises is Contractor's responsibility.

8.5 SURFACE PREPARATION OF STEEL

One or more of the following methods of surface preparation shall be followed, depending on condition of steel surface and as specified in data sheet. Engineer reserve the right to instruct the type of surface preparation depending upon the condition of material. Recommended methods of surface preparation of steel briefly are as under.

(a) Solvent cleaning.
(b) Manual or Hand tool cleaning
(c) Mechanical or Power tool cleaning.
(d) Abrasive Blast cleaning.

It is necessary that the Contractor may have to resort to any one or combination of the above method of surface preparation to achieve the required acceptable standard. Hence the rate quoted shall consider for such preparation.

8.5.1 Solvent Cleaning:

All contaminants like oil, grease removal shall be carried out either by special solvents or by degreasing agents. Application and cleaning of solvents shall be as per manufacturer's instructions and shall be in accordance with SSPC-SP1.

8.5.2 Manual or Hand Tool Cleaning:

This method of cleaning shall be used to remove all loose mill scale, loose rust, loose paint and other loose detrimental foreign matter by use of non-powered hand tools. The minimum acceptable standards in case of manual or hand tool cleaning shall be in accordance with ISO 8501- St2 / SSPC-SP2.

8.5.3 Mechanical or Power Tool Cleaning:

This method of cleaning shall be used to remove all mill scale, rust, paint and other detrimental foreign matter by use of power assisted hand tools. The minimum acceptable standards in case of power tool cleaning shall be in accordance with ISO 8501- St3 / SSPC-SP3.

8.5.4 Abrasive Blast Cleaning (Shot Blasting / Grit Blasting):

a) Shot / Grit blasting shall be resorted to only after removal of grease, oil and other contaminants as per SP-1. Special care shall be taken on weld areas to remove flux and spatter. Precautions shall be taken when grit or shot blasting of light gauge steel surfaces, to ensure that buckling does not occur due to continuous impingement of grit or steel shots under high velocity. Surface anchor profiles shall be measured by Tested tape – press-o-film and the finished surfaces shall conform to the requirements of ISO 8501 Sa 2½.

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/ SSPC-SP10.

b) Blast cleaning shall not be performed where dust can contaminate surfaces undergoing such cleaning or during humid weather conditions having humidity exceeding 85%.

8.5.5 **Tests on Surface Preparations:**

The following inspection and tests shall be performed on the steel surfaces subjected to surface preparation. Test / inspection reports shall be submitted to Engineer for his approval and acceptance.

a) Visual examination of surface preparation with comparators.
b) Profile check of the prepared surface with suitable "profilometer "e.g. TESTEX method.

8.6 PAINT MATERIAL

8.6.1 **Procurement:**

All types of paint required for the work shall be procured from the reputed manufacturers. However, contractor shall obtain the detailed list of approved paint manufacturers from the Engineer before initiating the procurement action.

8.6.2 **Storage:**

The Paint material shall be stored strictly in accordance with the instructions of the paint manufacture. In general painting materials should be stored in dry, cool, well ventilated and frost-free area.

8.6.3 **Packing:**

All paints delivered to the fabrication shop / site shall be in original sealed container, as packed by the manufacturer. Paint containers shall clearly mark with paint manufacturer's name, batch number, date of manufacture, shelf life and aclear indication of the type and color of the product.

8.6.4 **Mixing:**

a) Paint shall be thoroughly mixed prior to application. Mixing shall be done in a well-ventilated, clean and dust -free area. Paint shall be mixed by rotating power mixers or rolling rigs, until a uniform consistency is achieved.

b) Multiple pack paint materials shall be mixed in accordance and under the conditions as specified by the paint manufacturer. Pot life as specified by the paint manufacturer shall be strictly followed.

8.6.5 **Thinner and Solvents;**

Only additives, thinners, solvent etc. as recommended by the paint manufacturer shall be used. A possible extension of the "pot life" by additions of thinners is prohibited.

8.6.6 **Tests on Paint:**

In order to ensure that the supplied paint meets the stipulations, samples of paint shall be tested in laboratories to establish quality of paint with respect to

(a) Viscosity,

(b) Adhesion/ bond of paint in steel surfaces,
(c) Adhesion / simulated salt spray test,
(d) Chemical analysis (percentage of solids by weight),
(e) Normal wear resistance as encountered during handling & erection,
(f) Resistance against exposure to acid fumes etc.

Alternatively, manufacturer's test certificates shall be furnished by the Contractor in respect of above tests for Engineer's approval and acceptance. Engineer reserves the right to test the paint material either before the commencement of work or during the progress of work if in his opinion the paints supplied are of inferior quality and does not meet the coal requirements.

8.6.7 **Paint Sample:**

Before buying the paint in bulk, it is recommended to obtain sample of paint and establish "Control Area of Painting". On control area surface preparation, painting shall be carried out in the presence of Engineer and the Manufacturer of the paint.

8.6.8 **Finishing Paint:**

Color / Shade of the finishing paint shall be as per the choice of The Employer and Contractor shall obtain prior approval before procurement action is initiated.

8.7 PAINT APPLICATION

Painting shall be carried out by any one or the combination of the following method of application to suit the site condition and the type of paint being used. Manufacturer's recommended method of application shall be strictly followed.

(a) Brush Application.
(b) Roller Application.
(c) Spray Application.

8.7.1 Brush Application:

Brush application of paint shall be in accordance with the following,

(a) Brushes shall be of a style and quality that will enable proper application of paint.
(b) Round, Oval or Wide flat brushes shall be used depending upon the surface irregularity, rough or pitted steel, large flat painting areas etc
(c) There shall be a minimum of brush marks left in the applied paint.
(d) Surfaces not accessible to brushes shall be painted by spray.

8.7.2 Roller Application:

Suitable rollers of different nap length to suit varying surface roughness shall be used. Rollers are not generally recommended for application of primers. Roller application shall only be used if the first or priming coat of paint has been applied by brush or other means. Manufacturer's recommendation shall be strictly followed for roller applied paints.

8.7.3 **Spray Application:**

(a) Airless or pneumatic spray application shall be in accordance with the following,

(i) Airless spray application shall be as per steel structure paint Manual Vol 1 & Vol 2 SSPC, USA.

(ii) Spraying shall be carried out keeping the spray gun at the minimum suitable distance from the work piece and consistently at 90 0 to the surface being painted.

(iii) Correct spray tips, air pressures etc as recommended by the equipment supplier shall be used.

(b) Air spray application shall be in accordance with the following,

(i) The equipment used shall be suitable for the intended purpose, shall be capable of properly atomizing the paint to be applied, and shall be equipped with suitable pressure regulators and gauges.

(ii) Appropriate pressure and nozzles shall be those recommended by the manufacturer of the equipment for the material being sprayed. The equipment shall be kept in satisfactory condition to permit proper paint application.

(iii) Correct combination of air volume, air pressure and fluid flow to give good atomization shall be ensured to get a defect free painted surface.

(iv) Traps or separators shall be provided to remove oil and condensed water from the air. These traps or separators must be of adequate size and must be drained periodically during operations. The air from the spray gun impinging against the surface shall show no condensed water or oil.

(v) Ingredients shall be kept properly mixed in the spray pots or containers during application by continuous mechanical agitation.

(vi) Spray equipment shall be kept sufficiently clean so that dirt, dried paint and other foreign materials are not deposited in the paint film. Any solvents left in the equipment shall be completely removed before applying paint to the surface being painted.

(c) Selection of type of spray application shall depend upon the type of paint coating being used. At all-time paint manufacturer's recommendation shall be strictly followed.

8.8 **Coating Procedure**

8.8.1 General Compatibility between primer, intermediate and topcoats, as applicable for individual painting system shall be established through the paint manufacturer supplying the paints. Primer and finishing paint for the entire project shall preferably be procured from the same manufacturer. Mixing of material from different manufacturers is strictly prohibited

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8.8.2 Surface shall not be coated in rain, wind, when steel surface temperature is less than 50 C, or when the relative humidity is greater than 85%.

8.8.3 Applied paint system shall be allowed to cure at ambient and surface temperatures between 10 ° C and 60 ° C with relative humidity below 85%. All paint shall be air curing.

8.8.4 A suitable test area (approx. 0.5 m2) shall be painted with agreed paint system. The test area shall be fully coated with all coats of the agreed coating system using the tools and equipment to be used for the actual coating work. The painted test area shall be maintained for the duration of the project. Painting on test piece shall be carried out such that all the coats shall be made visible for reference at all time.

8.8.5 Structural steel shall be preferably prime coated at shop and subsequent finish coats shall be carried out at site after the alignment and erection is complete. Portions of structural steel members to be embedded into the concrete shall not be painted.

8.8.6 Surfaces inaccessible after assembly shall receive two coats of primer prior to assembly.

8.8.7 Surfaces inaccessible after erection, including top surfaces of floor beams supporting grating / chequered plate / RC Slabs shall receive one additional coat of finish paint over and above the number of coats specified prior to erection.

8.8.8 Each coat of paint material shall be applied as continuous film of uniform thickness free of porous. Any spot or areas missed in application shall be recoated and permitted to dry before the next coat is applied. Applied paint should have the desired wet film thickness.

8.8.9 Each coat shall be in proper state of cure or dryness before the application of succeeding coat. Material shall be considered dry for recoating when an additional coat can be applied without development of any detrimental film irregularities, such as lifting or loss of adhesion of the under coat. Manufacturer's instruction shall be strictly followed for intercut intervals.

8.8.10 No paint shall be force dried under conditions which will cause checking, wrinkling, blistering formation of pores or detrimentally affect the condition of the paint.

8.8.11 No drier shall be added to paint on the job unless specifically called for in the manufacturer's specification for the paint.

8.8.12 Paint shall be protected from rain, condensation, contamination, snow and freezing until dry to the fullest extent practicable.

8.8.13 Blast cleaned surface shall be coated with one coat of primer before surface degradation occurs but in no case later than 3hrs. Irrespective of the method of surface preparation, the first coat of primer shall be applied not later than 2-3 hours after preparation and on dry surface.

8.8.14 When the successive coat of the same color is specified, alternate coat shall betinted as far as practicable; sufficiently to produce enough contrast to indicate complete coverage of the surface. The tinting material shall be compatible with the material and not detrimental to its service life.

8.8.15 All field welded areas on shop painted item shall be mechanically cleaned (including the weld area proper, adjacent areas contaminated by weld spatter orfumes and areas where existing primer, intermediate / finishing paint is burnt). Subsequently, new primer and finishing coats of paint shall be applied as per painting specification.

8.8.16 Care shall be taken to protect adjacent equipment, piping, structures etc., from spillage and spatter during field painting by use of adequate temporary covers. Ifsurfaces are accidentally spattered or sprayed, the paint shall be immediately and thoroughly removed. For cleaning of spillages an inert absorbent material shall be used

8.8.17 All structures shall receive appropriate number of primer, intermediate and finishing coats in order to achieve overall DFT as per the drawings / specifications/ data sheets.

8.9 PAINTING SYSTEM

The recommended painting system of all Structural Steel Works covering surface preparation, application of Primer coats, Intermediate coats (if specified) and Final coats to develop required minimum DFT shall be as per manufacturer's detailed specification.

8.10 REPAIR OF COATED SURFACE

8.10.1 Wherever shop primer painting is scratched, abraded or damaged, the surfaces shall be thoroughly cleaned using emery paper and power-driven wire brush wherever warranted, and touched up with corresponding primer. Touching up paint shall be matched and blended to eliminate conspicuous marks.

8.10.2 If more than 30% area of the painted surface of an item requires repair, the entire surface shall be repainted. In such an event no, extra payment will be permitted.

8.11 TESTS ON PAINTING SYSTEM:

Following inspection and tests shall be performed during and after the application of paint system.

8.11.1 Wet film thickness (WFT) spot checks shall be carried out during painting operation to ensure that film thickness is being maintained.

8.11.2 Dry film thickness (DFT) check of intermediate and final coating layers in accordance with the specification and /or paint manufacturer's recommendation.

8.11.3 Quality of adhesion between the coating system and the steel substrate and of the adhesion between the coatings layers shall not be less than those specified in the Codes/ Standards.

8.11.4 Porosity Check: Holiday detection test shall be carried out and all indications shall be repaired as per approved repair procedures.

8.12 FINAL INSPECTION

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8.12.1 As part of the Quality Assurance, a final inspection in the presence of the representatives of The Employer and Contractor shall be conducted prior to the final acceptance of the paintwork.

Part of this final inspection checks shall include:

(a) Visual check of the appearance,
(b) Checks on DFT's of the total applied coating system,
(c) Shade verification,
(d) Holiday Testing,
(e) Scratch Test,
(f) Adhesion test.

8.12.2 As part of acceptance procedure, a report shall be prepared that shall include:

(a) General:
Names of the Painting Contractor and the responsible personal, Scope of work,
Dates when the work was carried out, Copy of the work and quality plan,
Deviations from this Specification and/or the quality plan.

(b) Inspection equipment
Type and calibration of instruments used.

(c) Surface Preparation
Condition of surface before preparation,
Checks on the requirements as specified for cleaned surface.

(d) Coating application
Information on coating systems being applied (i.e. product names, DFT's),
Checks on requirements as specified for coating application,
Check on dry film thicknesses of the total coating system applied.

(e) Conditions
Checks on humidity, dew point and substrate temperature.

(f) Inspection reports
Copy of the inspection reports of the Contractor, Inspection from an independent third party.

8.13 DOCUMENTATION:

Contractor shall keep records and furnish the following documents to The Employer:

8.13.1 A written quality plan with procedure for qualification trials and for the actual work,

8.13.2 Daily progress report with details of weather conditions, of applications, number of coats and type of material applied, anomalies, progress of work versus program,

8.13.3 Results of measurement of temperatures relative humidity, surface profile, film thickness, holiday detection, adhesion tests with signature of appropriate authority,

8.13.4 Of surface preparation and paint application during trials and during the work,

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8.13.5 Details of non-compliance, rejects and repairs,

8.13.6 Type of testing equipment's and calibration,

8.13.7 Code and batch numbers of paint materials used to include shelf life,

8.13.8 Visual examination of surface preparation compared with the standards,

8.13.9 Profile check of the prepared surface with suitable "profilometer,

8.13.10 Dry film thickness check of intermediate and final coating layers, in accordance with the specification and/or paint manufacturer's recommendation,

8.13.11 Checks/ tests carried out as per clauses above.

8.14 GUARANTEE:

8.14.1 The paint system shall provide enough protection of the underlying steel surface against the attack of the environment, other than mechanical damage, chemical spillage as result of operational activities or other unusual occurrences from the outside caused by others.

8.14.2 The Contractor is fully responsible for the quality of the work and for all related QA/QC activities as indicated in the specification.

8.14.3 The Contractor shall guarantee quality of their coating works for the period specified in Data Sheet-B and for the coating condition as specified below.,

8.14.4 The guarantee period starts from the date of acceptance of Contractor's paint work.

8.14.5 Initial acceptance of any new coating work by The Employer will not release the Contractor of his obligation under this section until final inspection has been carried out and acceptance of the completed work has been agreed in writing.

8.14.6 These guarantee clauses regarding coating specifications are prevailing and supersede the warrantee requirements in General Conditions of Contract.

SECTION F - Design and Construction of Toll Plaza

The Outline Specifications for the design and construction of the MTHL involved in the Works are givenbelow.

1.1 Design criteria and Standards

Except where specifically permitted otherwise by the Engineer in writing, the Contractor's design ofthe MTHL shall be in strict accordance with the following design standards and/or specifications applicable. If there are any latest Versions of the standards/ Codes, the same shall be applicable.

Table 1.1.1 - IRC and Other Standards and Specifications

Code No.	Title
IRC: 2-1968	Route Marker Signs for National Highways
IRC: 27-2009	Specifications for Bituminous Macadam
IRC:12-2016	Unified Guidelines for Access Permission to Fuel Stations, PrivateProperties, Rest Area Complexes and Such Other Facilities Along National Highways (Fourth Revision)
IRC: 30-1968	Standard Letters and Numbers of Different Heights for Use onHighway Signs
IRC: 35-1997	Code of Practice for Road Markings
IRC:67-2012	Code of Practice for Road Signs
IRC:98-2011	Guidelines on Accommodation of Utility Services on Roads in UrbanAreas
IRC:103-2012	Guidelines for Pedestrian Facilities
IRC: SP: 87-2013	Manual of Specification & Standards for Six Laning of Highwaysthrough Public Private Partnership
IRC: SP-99-2013	Manual of Specifications and Standards for Expressways
IRC: SP-85-2010	Guidelines for Variable Message Signs

IRC: SP-110-2017	Application of Intelligent Transport System for Urban Roads
IRC: SP: 119-2018	Manual of Planting and Landscaping of Urban Roads
NBC:2016 – VOL 1 & VOL 2	National Building code of India for Architectural design, Structuraldesign and Services.
Navi Mumbai DCR	Development Control Rules for Navi Mumbai
Mumbai DCR 2034	Development Control Rules for Mumbai

1.2 Design and Drawing software

The computer software for the design of the MTHL shall be approved by the Engineer prior tocommencement of the design works.

All the Contractor's drawing for submission to the Engineer shall be prepared using the Autodesk ofthe version acceptable to the Engineer, unless otherwise permitted in writing by the Engineer.

1.3 General requirement of Toll Plaza

i. TOLL PLAZA: The Toll plazas shall be installed along the MTHL at three locations, shall be designed and constructed as per IRC codes, where all lanes Electronic toll collection lanes (ETC). One Maintoll plaza shall be designed and constructed at Chirle around on earth STA 19+400, Six Ramp TollPlaza at Shivajinagar interchange on bridge and one toll plaza for out ramps at Sewri at STA 0+650 of E-W Corridor.

ii. TOLL ISLANDS: The elevated platform for the toll island should be installed in accordance to theapplicable IRC design standards. Construction of Median and Island above the road level with approved material deposited at site from roadway cutting and excavation from drain and foundation of other structure, spread, graded and compacted as per clause 407. Protective barriers of reinforced concrete and traffic impact attenuators shall be placed at the front of each island to prevent out of control approaching vehicles crashing into the toll booth. The protective barriers shall be designed to withstand the impact of the potential maximum vehicular collision force and other loads in accordance with IRC standards, constructed with R.C.C. M30 Grade concrete with HYSDreinforcement conforming to IRC:21 and dowel bars 25mm dia 450mm long at expansion joints filled with pre-moulded asphalt filler board, keyed to the structure on which it is built and installed as perdesign given in the enclosed to Most circular No. RW/NH – 33022/1/94-DO III dated 24 June 1994as per dimensions in the approved drawing and at locations directed by the Engineer, all as specified etc. complete. Spec: MORT & H 2013 Cl 811 Page No 360. Alternatively, where approved by theEngineer

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steel-fabricated protective barriers may be provided as per the applicable IRC codes. The Contractor shall select barriers of the most suitable type and/or structure for installation under theContract. The Contractor shall submit the proposed design of the barriers to the Engineer for approval. The vehicular crash barriers shall be durable in the saline environment. They shall be painted with reflective chevron markings.

iii. TOLL CANOPY: The canopy shall be designed and constructed as per the employer's requirements and shall be wide enough to provide weather protection to toll operators, drivers, and facilities, designed with steel structure/ trusses and covering tensile fabric. The contractor shall provide & fix

of steel fabricated structure for canopy including Banana Trusses as per design and steel columnsas per IS 875 including cost of all materials, labour transportation, incidentals, painting with synthetic enamel paint of approved shade complete) including facia and cladding as per drawing & as directed by engineer in charge.

iv. TOLL BOOTHS: Toll booth shall be placed at the centre of each traffic island. Toll booths shall bedesigned and constructed as per the employer's requirement and should be accordance with IRCstandards. The toll booth shall be equipped with required furniture, computer, printer, cash box, CCTV provision and other requirements specified with provision for light, fan and air conditioning.

v. CASH TUNNEL/ SERVICES TUNNEL: Tunnel below the toll booth of minimum 3-meter wide and 3 meters height needs to be excavated as per the services requirement. Spiral metal staircase shallbe installed in each of the toll booth to access the tunnel. The tunnel to be designed to have provisions for light and ventilations systems. Floor finishes and wall finishes should be per the outline specifications.

1.4 Specifications for Toll plaza structure

1.4.1 Codes & Guidelines

The design is to be performed according to the relevant Indian Standards (IS).

- IS 800 (2007): General construction in steel - code of practice.
- IS 875 (1987): Part 2 - Code of practice for design loads (other than earthquake) for buildingsand structures – Imposed Loads.
- IS 875 (2015): Part 3 - Code of practice for design loads (other than earthquake) for buildingsand structures – Wind Loads.
- IS 1893-1 (2002): Criteria for earthquake resistant design of structures, part 1.For the information missing in the standards, following codes shall be adopted -
- Eurocode 3 - Part 1-8 (EN1993-1-8) Design of steel structures - Part 1-8 Design of joints.
- CIDECT 1: Design guide for circular hollow section (CHS) joints under predominantly staticloading.

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1.4.2 Structural Analysis & Design for Toll Plaza Structure

i. Loads

- All applicable loads shall be considered as per relevant Indian standards – latest revision.
- Self-weight of the membrane shall be considered as per the manufacturer's data.
- Special attention shall be given to the cross-sectional shape and façade of the existing Building with regards to wind actions.

ii. Analysis

- The structural analysis is to be accomplished with the state-of-the-art finite element program.
- Structural calculation for the tensile structure shall include the following:
  - Large deflection numerical shape generation that will insure a stable, uniformly stressed,three dimensionally curved shape which is in static equilibrium with the internal pre-stressforces and is suitable to resist all applied loads.
  - Large deflection finite element method structural analysis of the membrane system underall applicable applied wind and live load conditions.
  - Large deflection finite element method structural analysis of the support frame system.
  - Biaxial fabric test specification, interpretation, and fabric compensation determination.
  - Accurate generation of the two-dimensional compensated fabric templates required togenerate the three-dimensional equilibrium shape.
  - Member size calculations of all primary structural members.
  - Connection design including bolts, weld, and secondary member sizing.
  - Checking/ verifying adequacy of the existing steel structure for the proposed membraneroof structure.

Checking the adequacy and/or taking responsibility of the existing RCC framed structure for the proposed tensioned membrane roofing system is NOT in the scope of the Contractor.

iii. Structural Steel

- All Steel members shall be designed according to IS 800:2007 for steel structure.
- Deflection limits – According to paragraph 5.6.1 of IS 800: 2007 the deflection under serviceability loads of a structure should not impair the strength of the structure or componentsor cause damage to finishing. Considering that the PVC/PES roofing does not imply specific deformation limits, the criteria for deflection check are assumed only to limit the impact of visible deformation as follow-
  - Vertical limit for cantilever = Span/100;
  - Lateral limit for columns = High/250.

iv. PVC/PES Fabric

Design of the PVC fabric is carried out considering an allowable stress approach. The allowablestress is defined as follows:

$ffff = ffffff / ssss$

Where $ffffff$ is the tensile strength in warp or in weft.SF is the safety factor evaluated as:
SF = 9 Permanent load case (Dead loads pretension)SF = 4 Short term load case (Live load Wind load)

1.4.3Material Properties for Toll Plaza Structure

i. Structural Steel

- All structural steel shall comply with - IS 2062. Fusion welding quality steel (Fe 410W GradeA) with minimum yield stress of 310 MPa shall be used for the structural steel works. The structural steel shall be cleanly rolled to proper dimensions and weight subject to Permissibletolerances as per IS: 1852
- Carbon steel pipes shall conform to IS 1161 or IS 1239 of Grade YST¬310 or Higher.

ii. Cables & Fittings

- The cables are to be considered as Spiral Strands with the following properties according toEN1993-1-11
  - Young's modulus E = 150000 MPa (typical value);
  - Rope grade $SSff$ = 1570 MPa (section 3.1 of EN 1993-1-11);
  - Coefficient of thermal expansion = 12*10-6 /°C (section 3.3 of EN 1993-1-11).
- All cables shall have SS 304 end terminations.
- All terminal fittings shall be SS 304 grade – having a breaking strength of the terminal detailnot lower than the specified minimum design load of cable system.

iii. Steel Bolts

Steel bolts are to be of specified of grade 8.8 conforming to IS 1367 (Part 3) Table 3.

iv. PVC/PES Fabric

It is to be adopted as standard PVC/PES type III according to European Design Guide for Tensile Surface Structures, Section 9.5.2. Table 2. The mechanical characteristics are reported below.

- Young's modulus E1 = 1150 MPa (typical value)
- Young's modulus E2 = 650 MPa (typical value)
- Poisson ratio v = 0.3
- Tensile strength warp/weft $ffffff$ = 115/102

Membrane roof at Club House of Eden Garden Stadium

The PVC/PES fabric of white or any desired Color selected by Client, shall be coated top andbottom with a protective PVDF Coating - weldable without grinding.

The color of the fabric is to be selected by Consultant / Client from the Manufacturers'

line of available colors. Color fastness to light of the fabric must be not less than 6 Note in accordancewith the German standard DIN 54004, DIN EN ISO 105 B02.

The Contractor shall provide 10 years' manufacturer's warranty for the fabric including the following

aspects -

- Fungus and mold growth.
- Structural properties (material strength, seam strength).
- Color and translucency.
- Capability to perform the folding process during the 10-year guaranty time without reduction of stiffness and strength and without visual damage. Folding operation for a temperature range between -5 °C to +50°C.

The warranty must cover the fabrication and installation of the product.

The coated material must be flame retardant and be of class B1 as per DIN 4102 (no burningdrops occurring). A certificate to this effect shall be supplied by the Contractor.

1.4.4 Fabrication for Toll Plaza Structure

i. Structural Steel

- Submit shop drawings. The drawings shall show in standard engineering drawing manner,clear and complete details of each assembly, component and connection in the work, together with information relative to their fabrication, surface treatment and erection.
- Fabricate and assemble structural steel in shop to greatest extent possible. Fabricate structural steel according to IS specifications (IS 7215; IS 12843; IS 800, IS 814; IS 816; IS9595).
- Fabricate architecturally exposed structural steel with exposed surfaces smooth, square, and free of surface blemishes, including pitting, rust and scale seam marks, roller marks, rolled trade names, and roughness.
- Cut, drill, or punch holes perpendicular to metal surfaces. Do not flame-cut holes or enlargeholes by burning. Drill holes in bearing plates.
- Weld threaded nuts to framing and other specialty items as indicated to receive other work.
- Where finishing is required, complete assembly, including welding of units, before start of finishing operations. Provide finish surfaces of members exposed in final structure free of markings, burrs, and other defects.
- Materials and workmanship are subject to inspection and test by the Engineer, who is always to have access to all parts of the workshop where steelworks are being fabricated and is tobe provided with reasonable inspection facilities.
- Unless shown on the drawings, site welding will only be permitted for minor connections subject to written approval from the Engineer.
- Do not place any welds, except those shown on the drawings, without approval.

even for temporary attachment and repair of faulty plates.

- Provide evidence of welder's competence to undertake specified work.
- Painting:
  - Preparation of surfaces – Sandblasting as per IS: 1477
  - Primer coat – Zinc rich epoxy primer having min. solid volume of 60% and product weightof 2.50
  - kg/ liter. DFT = 75 microns
  - Finish coat - Two component Hi-Built Epoxy coat pigmented with Micaceous Iron Oxidehaving minimum solid volume of 80 % and product weight of approx. 2 kg/ liter. DFT = 75microns

ii. Cables & Fittings

- Accuracy of Fabrication - The overall cable length including terminations shall comply withthe following tolerances at the pre-stress load:
- Strand +/-1mm for lengths less than 2 meters.
- +/-2mm for lengths greater than 2 meters but less than 5 meters.
- +/-3mm for lengths over 5 meters.
- Cutting - Cables shall only be cut using carborundum disc cutters or other approved mechanical devices. Under no circumstances will thermal cutting be approved.

  No splicing or joining of wire strands or ropes shall be permitted

iii. PVC Fabric

- Fabric shop drawings shall include all information necessary for the fabrication of the fabricmembrane. They shall include size and shape of envelope, type and location of shop and field connections, size, type, and extent of all heat welded seams.
- The seam lay out needs to be approved by the Engineer / Client.
- The shear angle resulting out of cloth width, length of each cloth and curvature must be limited to 2 degree. The shear angle can be derived using the European Design Guide forTensile Surface structures chapter 8.1 (8/3).
- The contractor will determine the correct cut of the membrane. The contractor is to determine, by means of tests for each cloth production unit, the characteristic values whichrelate to the biaxial expansion behavior of the membrane and are required in order to ascertain cutting pattern of the membrane.
- The cut-out areas are strengthened by attaching one additional membrane layer. Membrane reinforcements joining onto a membrane cable pocket require reinforcing of the membranepocket itself too.
- Exercise necessary care to plan and assemble the sections such that the assembly has no shop patches. Splices, if any, shall be patterned into a symmetrical and repetitive geometric arrangement within the assembly, shown on the shop drawings.

and where feasible hiddenby structural members.

- Exercise great care in marking, cutting, aligning, checking, welding seams and additions aswell as general handling and soiling prevention procedures to produce a smooth uniform surface with even curved edges free from irregularities and interfaces lacking wrinkling, cuts, abrasions, stains of marks, surface imperfections or welding aberrations.
- All membrane shall be patterned using finite analysis computer modeling. The membraneshall be cut using the latest CAD/CAM manufacturing technology with a tolerance of -1mm, +1mm.
- PVC joints shall be formed using ONLY high frequency equipment to a tolerance of +1mm, -1mm.
- Carefully plan the assembly to ensure that seams are always single laid and that a cut edgedoes not face uphill.
- Joints shall be symmetrical as specified by the cutting pattern. No short pieces or selvagewill be permitted.
- The joint between one membrane and the next shall have a welded seam of minimum 75 mm in width. All welds are slightly to be tensioned to line up weld marks during welding andto prevent weld shrinkage or uneven welds.
- All fabricated joints shall have a minimum of 90% of the total strength of the coated membrane in strip tensile testing. All structural joints shall be fused in accordance with industry standards and shall maintain the integrity of the coating.
- At positions where bolt or other penetrations of the fabric is shown or required, holes shallbe punched using a sharp 1 mm oversized punch. Holes shall be neat and have uniform edges.
- Rope edges shall be formed using VPDM 90 hardness polypropylene or approved polyester rope of minimum diameter 12 mm. All add-on details to the fabric shall use the same fabricjointing procedures as for structural joints.

1.4.5 Erection

i. Preparations

- Provide temporary shores, guys, braces, and other supports during erection to keep structural steel secure, plumb, and in alignment against temporary construction loads andloads equal in intensity to design loads. Remove temporary supports when permanent structural steel, connections, and bracing are in place unless otherwise indicated.
- Ensure that the capacity of plant and equipment used for erection are suitable and are in first class working order.

ii. Structural Steel

- Maintain erection tolerances of structural steel as specified in IS 12843

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- Align and adjust various members that form part of complete frame or structure before permanently fastening. Before assembly, clean bearing surfaces and other surfaces that will be in permanent contact with members. Perform necessary adjustments to compensate fordiscrepancies in elevations and alignment.
- Level and plumb individual members of structure. Splice members only where indicated.
- Do not use welding equipment on site without approval.
- Remove erection bolts on welded, architecturally exposed structural steel; fill holes with plug welds; and grind smooth at exposed surfaces.
- Do not use thermal cutting during erection unless approved by Engineer. Finish thermallycut sections within smoothness limits in AWS D1.1.
- Do not enlarge unfair holes in members by burning or using drift pins. Ream holes that mustbe enlarged to admit bolts.
- Ensure bolts are in center of slotted holes after erection of structure.
- Treat sliding surfaces of proprietary joints in accordance with manufacture'srecommendations before connecting.
- Friction grip type bolt installation procedure shall conform to IS 4000 (1992): Code of practicefor high strength bolts in steel structures.

iii. PVC Fabric

- Prior to commencement of erection, the Contractor shall check all contact surfaces to be incontact with the fabric for smoothness and remove causes for rips and/or scratching duringthe installation of the fabric panels.
- Contractor shall provide ground sheets where the membrane is to be dragged across a surface. Prevention of chaffing of the surface is always required.
- Access to the area where the fabric is to be installed shall be limited to only the authorizedpersonnel during the preparation and installation of the fabric structure for proper protection. The fabric shall be protected from damages upon installation.
- The contractor shall install the fabric structure in a sequence and with enough bracing to ensure stability of the structure.
- No creasing or folding of the fabric around sharp corners will be permitted. The fabric shallnot be abraded in any manner.
- The minimum pre-stress in the membrane shall be 2kN/m in both the warp and weft. The structure is to be tensioned after erection to maintain a taut smooth surface to minimum of
  +10%, -10% specified pre-stress levels.
- The fabric shall be stressed uniformly to avoid local over stresses.
- Damage occurring during the installation sequence may be temporarily repaired with field patches; However, permanent repairs shall be made with full panel replacement from seamto seam or seam to approved splice.

- Clean the fabric membrane after erection. Remove all signs of dirt and panel markings where visible by the naked eye.
- The final installed membrane should be wrinkle free. Maximum up to one place, & up to maximum 100mm wrinkle shall be allowed per 500 sq. m. area of the single structure. If the wrinkles appear at very prominent location and aesthetically unpleasing, the Engineer/ Client reserves all the rights to demand the replacement of the membrane.

1.5 Specification Toll Cabin Booth

1.5.1 Specification of Conventional Toll Cabin

i. Masonry Work- 100 mm AAC block

Providing and fixing precast Autoclaved Aerated Concrete (AAC) block 1:2:3:6 (1 lime: 2 fly ash: 3coarse sand: 6 graded stone aggregate 20 mm nominal size) of SIZE 600 (Length) x 200 (Width)x 100 mm (Height) including hoisting and setting in position with cement mortar 1:6 (1 Cement: 6Coarse sand). Compressive Strength (as per IS: 2185) should be 3-5 N/MM22, Dry density (ovendry) = 550-600 kg/m3, Sound reduction index (dB) for 200mm thick wall should be min 38-42 db.Thermal conductivity should be min 0.12 w/m °C, Drying Shrinkage should be min 0.08%, WaterAbsorption (at equilibrium) should be min 20-22%. Suitable plasticizer may be added if required.The fire rating and other structural requirements should be as per drawings.

ii. Plastering Work

- Providing and applying 18mm thick cement plaster with course sand in two coats, on all externalwalls 12mm thick cement plaster with course sand in one coats, on all internal walls, 6 mm thickcement plaster CM 1:4 to ceilings in single coat at all levels correct line and level and at all levels and heights' to correct lines with necessary scaffolding; and rounding off or chamfering of corners; cleaning of surface; raking out joints; roughening of surface; chiselling the undulated surface wherever necessary; curing; etc., including complete materials and labour. For external wall, Base coat of 12mm in C.M. 1:4 with waterproofing compound of mix 1kg for 50kg of cement withrough finish and second coat of 6mm in C.M.1:4 finished with steel trowel. For internal walls, coat in of 6mm in C.M.1:4 finished with steel trowel.
- Providing and applying 6 mm thick cement plaster CM 1:4 to ceilings in single coat at all levels correct line and level including scaffolding if any and rounding off or champhering of corners cleaning of surface, raking out joints, roughening of surface, chiselling the undulated surface wherever necessary and curing, etc. all materials and labour complete in all respects.
- Providing 12 mm thick water proof plaster in Toilet internal walls and overhead tank with CM 1:4 with water proofing compound of CICO No:1 or equivalent as per manufacturer's specification and roughening the surface in green condition with wire brush and level including scaffolding ifany, and rounding off or champhering of corners, cleaning of surface, raking out joints,roughening of surface, chiselling the undulated surface wherever necessary and curing, etc. allmaterials and labour complete in all respects.

iii. Vitrified Tile Flooring and Skirting

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Providing and laying Vitrified Ceramic floor tiles of make Kajaria / Somany / Johnson / Asian make or eq.,of required colour, design and shade as approved by the architect, glazed, polished/ satinfinished tiles in flooring , laid in patterns, without space between adjoining tiles, fixed over 20 mm(avg) thick base of cement mortar 1:4 (1 cement : 4 coarse sand) laid with cement slurry and skirting up to 75mm high fixed on 12mm thick cement mortar 1:3 (1 cement :3 coarse sand), including preparing the base, grouting the joints with approved polymer modified cementitious grouts of Bal Endura/Laticrete or equivalent make of the required colour and shade etc. cleaning, acid wash, finished surface protection all complete as per the architectural drawings and as directed by the Engineer-in-Charge.

iv. Painting-Internal Oil Bound Distemper with Putty finish

Providing and applying three coats of oil bound washable distemper of approved manufacturer like Asian / Berger / Nerolac / ICI Dulux or equivalent and of required shade on surfaces to give an even shade including a priming coat with alkali resistant primer and two coats of readymade putty of approved manufacturer, and applied as per manufacturer's specification after thoroughly brushing the surface free from mortar dropping and other foreign matter, preparing the surface even and sand papered smooth including all materials and labour. OBD shall be as per IS 428:2000 and IS 427:1965.

v. External Wall Cladding

Providing and fixing ceramic porcelain stone tiles/ ACP panels of thickness 3mm or 6mm, fixed using necessary stainless steel cramps, pins, expansion hold fasteners etc. by keeping a gap upto 50 mm from the existing backing R.C.C / Masonry walls and providing & filling non-streaking high performance silicone sealant DC 991 HP of Dow Corning or equivalent approved make, of approved colour and shade in the joints, to make the joints water tight, tooling it, including providing & fixing open cell foam backer rod etc. including preparation of the surface of substrate as per the manufacturer's specifications; providing and removing masking tape etc. as per Architectural drawing and as directed by the Engineer-in-Charge. Tolerance in thickness shall be maximum +
1.00 mm

vi. Glass Panels – Ticketing

Clear laminated glazed panels of 13.5mm thick. (6mm Glass +1.52 PVB +6 mm Glass) or equivalent based on the panel size fixed at Bottom, Sides and Top in stainless steel Grade 304 guide channels minimum 2 mm thick including any structural assembly to hold the top guide channels firmly and rigidly in place against any lateral loading as per code and Specifications. Theglazed panels shall be sealed with a silicone loading as per code and Specifications. The glazed panels shall be sealed with a silicone sealant compatible with the glass panel. The glass windowsinclude all necessary openings within the glass and door hardware. The preparation of laminatedglass shall be as per BS:952 Part-1

vii. Door

Providing and fixing solid core flush door shutters (single leaf), core of block board construction with frame of 1st class hard wood bonded by phenol formaldehyde synthetic resin adhesive conforming to grade as specified in IS:848:1974 including providing and fixing 35x12mm thick internal lipping on all sides with paint to be terminated at the edge of lipping, as per the architectural drawings, as specified and as per the directions of the

Engineer-in-Charge. Painted as per required colour and Engineer-in Charge. Rate shall include painting as per required colour and shade as per the manufacturers specifications and the directions of the Engineer-in-Charge. The lipping colour to match the shutter colour. The thickness of the treated hard wood core shall be 35mm thick ISI marked flush door shutter and finished with two coats of Synthetic enamel paint on both sides applied over a coat of primer. The shade of paint shall be as approved by the architect in charge. The Iron Mongery shall be as per schedule including all necessary hardware and labourcomplete fixing the Flush shutter to the MS Frames, aligning etc.

1.5.2 Specification of Portable cabin

i. Framing

- Bottom Frame 150 mm M.S. Channel
- Top Frame 150 mm M.S. Channel/ Sq. Pipe
- Bottom Stiffener 100 x 50 mm x 2mm rectangular M.S. Sq. Pipe, channel, Pipe
- Top Stiffener 40 x 20 x 1.8 mm. Specially formed M.S. section.
- Side Post 72 mm x 72 mm x 4 mm M.S. Sq. tube.
- Side wall stiffeners 1.2 mm specially formed CRC sheets.

ii. Outside Panelling Specially CRC Grooved Sheet

Side and End Walls: The side and end frame shall be made of pressed sections of suitable profiles/pillars of enough strength. Exterior wall shall be made up of 18 swg. MS specially corrugated sheet whereas 9 mm particle board will be used for interior walls. The steel sheet shallbe treated for corrosion resistant. Panels shall be vertically corrugated; sheet shall be continuously welded to top side and base structure to offer better strength to weight ratio. All gaps will be sealedat edges and at seams, bottom etc

iii. Internal walls Panelling 8 mm MDF OSL Sheet: The interior shall be aesthetically finished to givecustom built appearance with extremely high-quality workmanship. All vertically and horizontal corners shall be neatly and smoothly finished with GIS sections.

iv. Outside Roof Self draining type & watertight roof shall be made of 18 swg. M.S. sheet, adequateroof bows are to be provided. Roof shall be adequately cambered for draining of rainwater. Interior panelling shall be done in 9 mm particle board with adequate insulation Galvanized specially Grooved Sheet – 1.2 mm thick properly sloped & watertight.

v. False ceiling 8 mm MDF/8mm cement bonded fibre board – plane white (100% water, Termite &Dimensional proof)

vi. Bottom flooring on the bottom frame 19 mm thick plywood, bison panel/Cement Board shall be fixed by means of self-taping screw. PVC vinyl flooring shall be fixed on the panel. – plane white(100% water, Termite & Dimensional proof) with Vinyl Carpet for three cabins & for storeroom cabin checker plate flooring.

vii. Aluminium Windows: 04 Nos facing each other on 20 ft walls for 3 cabins & one for toilet block inpassage area. Window of size 4' x 3' will be made of powder coated aluminium sections. With double shutter horizontal sliding arrangement windows will be provided with safety grills along with weather shades for doors & window & 4 mm tinted grey glass.

make – Saint Gobain / ASIS.

viii. Door: The door shall be of external opening type of size 7' x 3 'made of the same material as wallpanels with door closing unit. The construction of the door shall be double skin steel constructionwith 40 mm thick Glass wool insulation. The door interior shall be finished with same material matching with that of the cabin interior. The door shall be provided with locking arrangement withseparate handles of both sides of the door as required. Main door will be insulated and fitted withappropriate lock and power bolt. Weather shed shall be provided on the door frame.

ix. Insulation: Insulation of rock wool sandwiched in between external galvanized sheet and inside laminated particle board. 50 mm thick Glass wool insulation shall be used for walls and 50 mm thick Glass wool insulation to be provided for roof. Rock Wool density of 48 Kg/M3. It leads to lower thermal conductivity & high résistance to moisture & heat.

x. Wiring: The cabin shall be provided with concealed electrical wiring complete with Main Board, tube light fixtures, door light, fan, switches/socket, telephone line connector, ISA 3 pin socket with 30 ADP switch for power point, 3 pin sockets with 5 A switch for light point. The cabin shall be provided with Earth leakage circuit breaker for protection and safety from electrical shock. All wiring shall be concealed type & shall be PVC insulated copper wire of approved grade & make. Contractor shallprovide necessary earthing for safety point of view and provide suitable size of legs for all four corners to the portable cabin. Mains MCB should be provided at the outside of cabin with protection cabin.

xi. Electrical Fitting: The Portable cabins will be provided with electrical wiring suitable for 220 –250-volt, 50 HZ single phase AC power supply. Suitable ISI marked copper cables shall be used for lighting circuits. The copper cables used will be of 2.5 mm Sq. cable for lighting circuits. ISI markand concealed in PVC conduits insulated copper wire shall be used for wiring to be done in PVCconduit with small size distribution board with MCB protection and to separate with main supply.

* Tubes, door light, fan, switches, 5/15A switch & sockets, 24W LED type wall mounted fittings with swan neck pipe fittings, Telephone, A/C points etc of ISI marked & of standard company.

* Earth leakage circuit breaker (ELCB) at the input junction for additional safety.

xii. Outside painting: Epoxy Zinc Phosphate primer, Asian / Berger Paint & synthetic Epoxy paint forfinal 2 coats. (Corrosion free paints) with required colour combination.

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FINISHES

SECTION – A WOOD WORKS

WOODEN FIRE AND ACOUSTIC FIRE DOORS

1.0 GENERAL

The Fire Doors and Acoustic Fire Doors shall not collapse during the ratedperiod of fire under the specified fire conditions and shall provide safe access to the escape route.

2.0 CODES & SPECIFICATIONS

The complete assembly of the doors i.e. frame, shutter, vision glass and hardware shall have fire rating as required and shall confirm to:

1.	IS 3614 Part II -1992	.Fire Resistance test & performance criteria
2.	BS:476, Part-6 & 7	Surface spread of flame test for FR Paint.
3.	BS:476, Part-20	Method for determination of the fire resistance of elements of construction (general principles).
4.	BS:476, Part-22	Method for determination of the fire resistance of non load bearing elements of construction.
5.	BS: 6206:1981	Specification for impact performance requirements for float safety glass andsafety plastics for use in buildings.
6.	EN:12600	Specification for impact performance requirements for flat safety glass.
7.	EN:1634 Part-1-1999	Fire resistance tests for Glazed doors & Partition and openable windows
8.	EN:1364 Part-1-1999	Fire resistance tests for non-loadbearing elements.

3.0 TESTING AND CERTIFICATION

The Fire Doors and Acoustic Fire Doors has been tested earlier at reputed by National or international reputed approved test house

Along with all material tests, the complete system along with the framing shall be tested in accordance with the criteria of BS 476: Part 22 1987/EN 1634/EN1363 along with necessary hardware.

4.0 DOOR FRAME

Door frames of minimum 120 minutes fire rating shall conform to BS: 476 part 22, IS:3614 Part II as per the prototype certified by CBRI Roorkee Door Frame will be made of 2nd class Teak Wood as approved by Engineer-in-charge. Door frame of section as specified or as indicated in the drawings,with heat activated intumescent fire seal strips of size 20 x 4 mm(for smoke sealing) provided in grooves on all three sides of the frame with one coat offire retardant primer of approved brand including two coats of fire retardantpaint untinned on cleared hard wood surface of door frames (@3.5 sq. m.per liter per coat) including reparation of base surface as per

recommendations of manufacturer to make the surface fire retardant. Theframe shall be fixed with 8 nos. 100 mm long, 10 mm dia metal dash fasteners of approved brand and manufacture or as per direction ofEngineer in charge. Both frame and shutter shall be fitted with fire & smokeintumescent seal of Viper or equivalent make of size 20 x 4mm on all the three sides except bottom.

5.0 FIRE DOOR SHUTTER

a) The Fire Door shutters shall be52mm thick tested as per BS:476 Part- 20 & 22 & IS 3614 Part-2 for stability, integrity and thermal insulation.Recommended fire door shall have doors tested at CBRI vide test report FR No. 0291 for maximum rating of 2hrs tested either with or without vision panel. Individual Test certificates should be available for glass used in vision lites confirming the required fire ratings.

b) The shutter should be maximum 52 mm thick with commercial ply facing and provided with laminate of approved brand and manufacturer 1mmthick.

c) The core insulation should be asbestos free comprising of two 12 mmthick Calcium Silicate boards of Pamtech type , 100% without Asbestos, having density not more than 900Kg/M3 and thermal conductivity 0.14 W/m*K with non-combustibility as per BS 476 part 4-1970 and class-1surface spread as per BS-476 Part-7-1971 .

d) These boards sandwiching 20 mm thick fire resistance insulation filler faced with 03 mm thick commercial ply facing on both faces. The doorfaces will be pasted with 1.0mm thick laminate as specified above. theshutter is provided with heat activated intumescent fire seal strip of size20mm x 4 mm mounted in the grooves of 2nd class teak wood Exposedlipping on all sides except bottom.

e) The intumescent fire-retardant sealant should be used to fill the gaps between civil opening and frame along with wool insulation to fill any visible gap. The manufacturer should submit desired design test reportfor a design tested earlier for 120 minutes fire rating along with Vision Panel tested at CBRI Roorkee as per directions of Engineer in Charge. The manufacturer should be an ISO certified and IGBC registered member.

f) Prototype Test certificate for fire rating of doors from CBRI, Roorkee forearlier tested design shall be attached along with manufacturers test certificate. Provisions/reinforcement for fixing all fixtures shall be built inon the doors prior to the supply.

g) Testing: The Client holds the right to get the door tested for fire rating atthe cost of the contractor/vendor. In case the Engineer-in-chargedesires to get the doors tested then one door including shutter, frame and all fittings shall be selected at random out of the entire lot and shallbe tested for two-hour fire rating. The testing shall be got done from CBRI, Roorkee. The cost of material for testing and transportation / packing & other incidental testing charges shall be borne by thecontractor. In case the door fails to meet the requirement, the entire lot shall be rejected.

6.0 ACOUSTIC FIRE DOOR SHUTTER

a) The acoustic fire door shutter shall be 77mm thick Non-metallic, Asbestos Free, Acoustic cum fire/smoke door of 120 minutes fire rating, conforming to BS: 476 part 22 IS: 3614part -II , suitable to achieve minimum 32db, sound reducing

properties suitable for fixingin wooden door frame of suitable section as specified above. The doors can be single ordouble leaf as specified in drawings or as directed by Engineer-in-charge.

b) The shutter comprising of 2 non -combustible boards sandwiching 41 mm thick fire resistant & acoustic insulation filler. The shutter is faced with 6mm thick commercial ply veneering on both faces and wooden lipping all around the shutter with heat activated intumescent fire seal strip of size 20x4mm on all sides except bottom (for smoke sealing) both in frame & shutter.

c) The door shall have suitable arrangement for the provision for acousticseals for sound reduction properties.

d) The shutter is fitted with the frame with the help of SS ball bearing hingesincluding all type of acoustic seal.

e) The door is fitted with Acoustic seals of approved make as per the details given below

   A. For perimeter of frame as per IS 1212.

   B. For meeting point of double leaf as per IS 7061.

   C. Automatic drop seal for the bottom of the shutters-IS 8010

f) Prototype Test certificate for fire rating of doors from CBRI, Roorkee forearlier tested design shall be attached along with manufacturers test certificate. Provisions/reinforcement for fixing all fixtures shall be built in on the doors prior to the supply.

Testing: The Client holds the right to get the door tested for fire rating at thecost of the contractor/vendor. In case the Engineer-in-charge desires to getthe doors tested then one door including shutter, frame and all fittings shallbe selected at random out of the entire lot and shall be tested for two-hourfire rating. The testing shall be got done from CBRI, Roorkee. The cost of material for testing and transportation / packing & other incidental testing charges shall be borne by the contractor. In case the door fails to meet therequirement, the entire lot shall be rejected.

7.0 HARDWARE

a) Fire rated panic exit device

UL listed fire rated single/double leaf panic exit devices tested in accordance with BS EN 1125: 1997 & BS EN 179: 1997, EN 1670(Corrosion Resistant), & BS 476 Part 22 (for fire rating) shall be provided atlocations as specified in drawings. The device shall be fixed with necessary hardware as recommended by the manufacturer. A minimum one-year warrantee is required for the product.

b) Fire rated door closer

Fire rated door closer tested in accordance with BS:476 Part 22 (for fire rating) and BS EN 1154 shall be provided wherever required. The door closer shall be fixed with necessary hardware as recommended by the manufacturer. A minimum one-year warrantee is required for the product.

c) Fire rated mortice lock Supply and fixing of Fire Rated Mortice Dead Lock 80mm both side key cylinder tested to 100000 cycles of approved make along with the fire rated door for 2 hrs. fire rating from CBRI Roorkee as per approved by Engineer in charge.

d) Tower bolt-

Supply and fixing of Stainless-Steel concealed Tower Bolt of 304 grade of approved make of size 10 mm dia rod approved make of size 10 mmdia rod and 250 mm long as per approved by Engineer in charge.

e) Pull handle-

Supply and fixing of stainless steel 304 Grade D - Type pull handleof size 300mm long 22mm dia of approved made as per directionof Engineer-in-Charge

f) Door Coordinator-

Suppy & fixing of door co- Ordinator for Co- ordination of double leafdoor of approved make as per approved by Engineer in charge.

g) SS Ball Bearing Hinges-

Providing and Fixing SS Ball Bearing Hinges of size 102 x 76 x 3mm(4"X3"X3mm) complete with SS Screws of approved make.

Mode of Measurement: -

a) Fire rated door frames shall be measured in running meter to the finished dimensions without any allowance for wastage or dimensionsbeyond specified dimensions. The rates shall include all operations asspecified above for working at all heights and levels including scaffolding, fire seal strips, fire retardant primer and paint excluding hold fasts / dash fasteners which shall be paid under the relevant subhead of the Bill of Quantities.

b) Fire Door shutter: - Final finished area of door shutter shall be measured after fixing it with the frame in the opening correct to one cm. The ratesshall be inclusive of all materials, T&P, Labour, etc. complete includingthe cost of fittings, testing, fire seal strips, laminate, wastages, fire retardant sealant, prototype testing etc. as described above at all heights and levels excluding hardware which shall be paid under the relevant subhead of the Bill of Quantities.

c) Acoustic fire door shutter: - Final finished area of door shutter shall bemeasured after fixing it with the frame in the opening correct to one cm. The rates shall be inclusive of all materials, T&P, Labour, etc. completeincluding the cost of fittings, testing, fire seal strips, laminate, wastages, fire retardant sealant, prototype testing, all hardware as specified in drawings or as directed by the Engineer-in-charge etc. as described above at all heights and levels.

d) Fire rated panic exit device – shall be measured in numbers of installedquantities and shall include all hardware, nuts, screws, washers etc required for fixing at all heights and levels.

e) Fire rated door closer – shall be measured in numbers of installed quantities and shall include all hardware, nuts, screws, washers etc required for fixing at all heights and levels.

f) Fire rated mortice lock – shall be measured in numbers of installed quantities and shall include all hardware, nuts, screws, washers etc required for fixing at all heights and levels.

g) Tower bolt— shall be measured in numbers of installed quantities andshall include all hardware, nuts, screws, washers etc required for fixingat all heights and levels.

h) Pull handle— shall be measured in numbers of installed quantities andshall include all hardware, nuts, screws, washers etc required for fixingat all heights

and levels.

i) Door Coordinator— shall be measured in numbers of installed quantities and shall include all hardware, nuts, screws, washers etc required for fixing at all heights and levels.

j) SS Ball Bearing Hinges— shall be measured in numbers of installed quantities and shall include all hardware, nuts, screws, washers etc required for fixing at all heights and levels.

SECTION – B

ALUMINIUM & GLAZING WORKS

1. **Aluminium louvers**
   1. All Aluminium alloys shall conform to IS:733 and IS:1285.
   2. The aluminium with micro coating louvers vertical section shall be 47.62 x 44.65 x 2mm, top & bottom section size shall be 114.30 x 44.65 x 2mm, aluminium flat section size shall be 44-65 (3mm thick), louvers section sizeshall be 63mm width (1.1 mm thick). The Contractor shall submit a sampleof the louvers for the approval of the Engineer before installation.
   3. The frame shall be anchored to the Masonry or concrete surface by means of 10/12mm diameter SS Anchor fasteners of suitable length as approved by Engineer.
   4. It will be supported by a secondary member held at the slab of every floorusing supporting brackets and bolts as per the drawings and directed by the engineer.
   5. Shop drawings with anchorage details as specified above shall be submitted for approval of the Engineer prior to commencement of works.
   6. All aluminium members shall be Powder coated in specified colours and thickness as per the approval of Engineer.

Mode of Measurement

Aluminum louvers: The measurement shall be based on the installed surface area including all supporting framework, wastages, supporting brackets, fasteners, framework, scaffolding, tools, plants, nuts, screws, powder coating etc. all complete for working at all heights and levels.

2. **Structure Glazing**

(i) Providing and fixing Structure glazing system semi unitised as per drawing with glass of approved make. The glazing unit shall be fixed to an aluminium sub-frame with structural silicon and 6.4 mm thick approved tape around the periphery of the unit and the subframe shall be mounted on the curtain wall main frame. The whole assembly shall be fixed to Aluminium framework by stainless steel screws. Periphery gap between the frame & aluminium framework to besealed by silicon non staining weather sealant of approved make. The aluminium sections shall be conforming to alloy 63400 WP with chemical composition and mechanical properties as per IS: 733:1983 and IS 1285:2002. All profiles shall be pure polyester Powder Coated according to IS: 137871:1993, 50 - 60 microns the in approved shade / colour.

(ii) The anchoring / bracing of the structure glazing to the RCC slab / beams / columns shall be done with non-corrosive galvanised brackets of approved design, with two numbers on each beam, one normal bracket and one restrainbracket, as per detailed design (design details for extended bracket to be submitted for approval) and including providing member and bracket (including providing and fixing of aluminium shims of various thickness to adjust the beam level/ line variations) with SS dash fasteners of min. 12mm dia. and depth of 50

-80 mm in the concrete and to withstand the dead load of the curtain walls as well as stresses due to wind pressure etc. (Galvanising of brackets to be doneconforming with IS:4759-1996 up to 610 gm/Sqm / 80 - 90-micron thickness)

(iii) The Expansion joints between two mullions should be created by inserting minimum 300mm long Aluminium Expansion Sleeves Tube, and the expansion gap should be minimum 10 mm. The Expansion joint must be properly sealed all around with weather sealant to make it watertight.

(iv) The glazing frame shall be aligned for the entire height of each mullion andfor the entire width of each Transom by laser beam equipment to ensure 100 percent 'X' axis and 'Y' axis alignment.

(v) The glazing framework shall be provided with approved in-built ventilation and drainage system and the entire joint must be properly sealed with weathersilicon to make the joint watertight. The details for in-built ventilation system shall be submitted by the contractor and got approved by the Engineer-in- Charge.

(vi) The system should also provide for pressure equalisation.

(vii) The periphery shall be sealed both from inside and outside with Non staining silicon weather sealant to make the glazing's water/ airtight.

(viii) All Screws, Bolts, Nuts and Washers used in the glazing shall be only Stainless Steel.

(ix) Gaps up to 10 mm between the peripheral aluminium member and masonry/R.C.C./Stone shall be sealed by weatherproof silicon.

(x) The Contractor shall submit the shop drawings along with the various design calculations for wind pressure and stability of the system and get the same vetted by an Engineering College as approved by the Engineer-in-charge. Warranty for structural silicone adhesion shall be got from the manufacture back to back.

Mode of Measurement: - The installed surface area shall be measured and considered for payment including all operations as listed above. Rates shall include all Cost of glass, aluminum framework, installation, anchor fasteners, sealants including all tool & plants and labor element for cutting of glass, stacking, carrying to heights and fixing in appropriate locations is to be included in the rate, including all scaffolding and safety arrangements.

3. **Vision Panel**

Providing, assembling and supplying vision glass panels (IGUs) comprising of hermetically sealed 6-12- 6 mm insulated glass (double glazed) vision panel units 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 inner Heat strengthened clear float glass 6mm thick, spacer tube 12mm wide, desiccants, including primary seal and secondary seal (structural silicone sealant) etc. all complete for the required performances, as per the Architectural drawings, as per the approved shop drawings, as specified and as directed bythe Engineer-in-Charge. The IGUs shall be assembled in the factory/ workshopof the glass processor.

Mode of Measurement For payment, only the actual area of glass on face # 1 of the glass panels (excluding the areas of the grooves and weather silicone sealant) provided and fixed in position, shall be measured in sqm. Rates shallinclude all Cost of glass including all tool & plants and labour element for cutting of glass, stacking, arraying to heights and fixing in appropriate locations is to be included in the rate, including all scaffolding and safety arrangements.

4. **Spandrel Glass panel**

Providing and supplying Spandrel Glass Panels comprising of 6 mm thick heat strengthened monolithic float glass of approved colour and shade with reflective soft coating on surface # 2 of approved Colour and shade so as to match the Colour and shade of the IGUs in the vision panels etc. ,all complete for the required performances as specified, as per the Architectural drawings, as perthe approved shop drawings, as specified, and as directed by the Engineer-in-Charge."

Mode of Measurement: For payment, only the actual area of glass on face # 1of the glass panels (but excluding the area of grooves and weather silicone sealant) provided and fixed in position, shall be measured in sqm. Theproperties of performance glass shall be decided by technical sanctioning authority as per the site requirement. Rates shall include all Cost of glass including all tool & plants and labour element for cutting of glass, stacking, carrying to heights and fixing in appropriate locations is to be included in the rate, including all scaffolding and safety arrangements

5. **12 mm thick tempered glass**

Providing, assembling and supplying vision glass panels (IGUs) comprising of12 mm thick tempered glass vision panel units of size and shape as required and specified all complete for the required performances, as per the Architectural drawings, as per the approved shop drawings, as specified and as directed by the Engineer-in-Charge. The IGUs shall be assembled in the factory/ workshop of the glass processor.

Mode of Measurement: "For payment, only the actual area of glass on face #1 of the glass panels (excluding the areas of the grooves and weather siliconesealant) provided and fixed in position, shall be measured in sqm. " . Rates shall include all Cost of glass including all tool & plants and labour element for cutting of glass, stacking, carrying to heights and fixing in appropriate locations is to beincluded in the rate, including all scaffolding and safety arrangements

6. **Aluminium Glazed fixed window**

Providing and fixing aluminum glazed fixed windows duly powder coated 50-60micron thick in approved Colors with provision of 24mm thick DGU toughenedglass (6+12+6) using high strength to weight aluminum sections of grade 63400 WP confirming to IS: 733 and IS: 1285 complete. The fabrication shall be donewith all joints metered, the outer frame, mullions and shutter frames joined withheavy duty aluminum Joineries.

Mode of Measurement: - The installed surface area shall be considered for measurement and payment. The rates shall include providing EPDM gasket, perforated aluminum spacers, desiccants, sealant (Both primary and secondary sealant) etc. as per specifications, drawings and direction of Engineer-in-charge complete at all heights and levels including the cost of scaffolding. Shop drawings to be submitted by Contractor for approval of Engineer-in-charge before commencement of work

7. **Lacquered Glass**

The works shall comprise providing and fixing of 4 or 6 mm thick Lacquered glass of approved Colour as per Drawings or directed by the Engineer. Fixed over 12mm BWP marine ply or RCC wall or any other structure with mounted on plain clip as per manufacturers recommendations or directed by theEngineer.

12mm thick BWP Marine ply

The material specifications are as follows

a. Density 650 kg per cum
b. Moisture content 8-10%
c. Bonding – BWP grade resin
d. Static bending strength – MOE: - Parallel to face grain > 6000N/mm²; perpendicular to face grain > 4500 N/mm²
   MOR: Parallel to face grain > 50 N/mm²; perpendicular to face grain > 45 N/mm²
e. Guarantee – 7 years against borer and termite
f. Tolerance
a. Length - +/-6mm
b. Width - +/- 3mm
c. Thickness - +/-5%
g. Preservative treatment: - GLP with CPP, ACC treatment

Lacquer Glass

a. Compressive strength Should be 1000MPa
b. Tensile strength Should be 40 MPa
c. Glass shall be fixed with a revolutionized system and Should be eco-friendly, light weight, ultra-strong, transparent polymer clips.
d. Horizontal load capacity should not less than 30kg/ 100mm
e. Vertical pull-out load >200kg/100mm.
f. Dry film thickness – 35 to 50 microns
g. Pendulum hardness - ≥100
h. Cross Hatch – max. 2

MMRDA

i. Salt spray test - ≥240 hours
j. Glass thickness tolerance - +/- 0.3mm
k. Size tolerance - +/- 2mm

Mode of measurement: - The payment shall be made based on the installed areaand shall include the cost of all operations as specified above. The quoted rates shall include cost of all material, all hardware's, fixtures, Glass, ply, fixing arrangements, labour, workmanship, tools, plants, scaffolding, hardware etc. for working at all heights and levels.

8. **Sandwich Blinds**

Providing and fixing motorized DGU sandwich Venetian Blinds with Motor of 24VDC, having met alluded gears and DGU with air gap of 29mm/32mm, All Aluminum Sections Anodized with Min 12 Microns , Spacers Anodized and serrated , Side spacers with Ribs to protect the light from the sides, Cords UVresistant , aluminum Slats 0.2mm thk coated. The slat overlaps of minimum 3mm for light blocking in closed position. IFT tested product for endurance and durability.
The Contractor shall take approval on shop drawings from Engineer-in-chargebefore commencement of works on site.

Mode of measurement: - The payment shall be made based on the installed areaand shall include the cost of all operations as specified above. The quoted rates shall include cost of all material, all hardware's, fixtures, Glass, motor, aluminum framework, fixing arrangements, labor, workmanship, tools, plants, scaffolding, hardware etc. for working at all heights and levels.

9. **Smart glass/Switchable glass**

The works shall comprise of Providing and fixing smart glass/ switchable glass of configuration 4mm clear toughened glass + 1.52mm PLDC film + 4mm cleartoughened glass shall be fixed with all gaskets, hardware's etc. as per manufacturers recommendations and direction of Engineer. The specificationsshall be as follows:

1. Response time should be less than 10 microseconds
2. It should work in temperature from -10°C to 60°C
3. It should be low power consumption <10W per sqm
4. It should be noise resistant
5. Working Voltage – 65V AC (50Hz)
6. Remote control – 25-meter working range
7. UV Blocking – 98%
8. Haze (level of blur) – 7% at ON mode and >95% at OFF mode
9. Visible light transmission - 74% at ON mode and 50% at OFF mode
10. Electrodes should be positioned at the top, bottom, left or right dependingon the size of the glass pane and the application intended as per approveddrawings and directed by the Engineer.

Toughened Glass

MMRDA

1. Shall comply with IS: 2835 (Latest version)
2. Roller Waviness test – as per ASTM C 1651
3. Compressive stress measurement – as per EN 12150-1
4. Fragmentation test – as per IS 2553-1
5. Ball Drop test - as per IS 2553-1
6. Bend / Bow test - as per IS 2553-1
7. Shot bag test – as per ANSI Z97.1
8. Local bow - as per IS 2553-1
9. Toughened glass made from AA or A quality sheet glass shall not have cluster of defects more than those specified for AA or A quality of sheet glass in IS 2835: 1987.
10. Toughened glass shall be of nominal thickness as specified and direction of the Engineer
11. Tolerance of Thickness shall follow:
    a. Thickness – 4.0 to 4.8mm
    b. Length or breadth - +/- 2.5mm
12. There are not more than 400 and not less than 40 particles in a square ofside 5 cm in the coarsest area as defined.
13. For toughened glasses made of figured glasses as material, the impact surface shall be the surface having no pattern.

PDLC Film

1. The density of film Shall be 7 grams per cm^3
2. Thickness of Film Shall be 1.52mm Thick

The Contractor shall submit shop drawings for the approval of the Engineer beforethe commencement of works on site.

Mode of measurement: - The payment shall be made based on the installed areaand shall include the cost of all operations as specified above. The quoted rates shall include cost of all material, hardware's, fixtures, Glass, PDLC Film, labour, workmanship, tools, plants, scaffolding, hardware etc. for working at all heights and levels.

10. Sage glass

Providing, assembling and supplying sage glass – laminated DGU with 5mm clear glass, 0.89mm Sentry PVB, 2.2mm Sage Glass, 12mm air space, 5mm clear glass units of size and shape as required and specifiedall complete as per the drawings and as directed by the Engineer-in- charge. The Specification for Sage glass shall follow: -

Level of tint	Inner Lite	%Tvis	%Rf Ext.	%Rb Int.	%Tsol	SHGC	U-factor btu/hr.ft².°F%Tuv	%Tuv	%Tdw-K
Clear State	6mm clear	60	16	14	33	0.41	0.28	0	15
Intermediate State 1	6mm clear	18	10	9	7	0.15	0.28	0	5
Intermediate State 2	6mm clear	6	10	9	2	0.10	0.28	0	2
Fully Tinted	6mm clear	1	11	9	0.4	0.09	0.28	0	0.6

The Contractor shall submit shop drawings for the approval of the Engineer beforethe commencement of works on site.

Mode of measurement: - The payment shall be made based on the installed areaand shall include the cost of all operations as specified above. The quoted rates shall include cost of all material, all hardware's, fixtures, Glass, labour, workmanship, tools, plants, scaffolding, hardware etc. for working at all heights and levels

11. Aluminium Glazed Door-

Providing & fixing of Aluminum Glazed Door (Single / double Leaf) with Glassinfill of 10 mm thick clear toughened glass with ATB 40 S system, with all around frames over the door. In combinations with Single / double glazing full height partition frameless up to ceiling level of the applicable Standard DIN 18202, DIN 1249 DIN EN ISO 12543. Framing shall be consisting of Aluminum profile 40 mm(H) X wall thickness
28 mm (Thickness), Wall, Ceiling & Floor Connection made up of Anodized Aluminum. Above false ceiling, vertical sections to be extended up to main ceiling and to be fixed with suitable accessories. Sound Insulation of 37 dB to be achieved using 10 mm thick toughened glasses of approved make confirming to DIN EN ISO 140-03, Joint width 3 mm. Complete in all respect with all suitable accessories as per manufacturer standards.

The works shall be carried out by utilization of profiles available with the manufacturer as per the approved list of makes. The installation shall be carried out with an installer certified / recommended by the manufacturer. The Contractor shall submit shop drawings for approval of Engineer-in-charge before commencement of works on site.

Mode of measurement: - The payment shall be made based on the installed areaand shall include the cost of all operations as specified above. The quoted rates shall include cost of all material, all hardware's, fixtures, Glass, framework,anchorage, labor, workmanship, tools, plants, scaffolding, hardware etc. for working at all heights and levels

12. Aluminium Glass Partition-

Supply and Fixing of Slim Glass partition of 12mm Toughened Glass includingframe, Profiles at Top & Bottom & at sides. The profile size to be 45x25MM tobe fixed on to the floor/wall/ ceiling as per the architect design. Junction profileto be used at all Glass to Glass vertical joints, 90 Deg L Junction Profiles and TJunction profiles necessary as per design. In case of Glass overall panel Overpanel Profile to be used. In case of Open glass edges End Profile to be used. The profiles shall be suitable for Glass thickness of 10/12/13. 52mm.The Profile shall be matt natural anodized, the Profile Manufacturer to supply all thenecessary clips, seals and fixing accessories for the system.
All Profiles to be with 2 mm Gauge thickness Excluding 50-60 Micron of Powdercoating.

The works shall be carried out by utilization of profiles available with the manufacturer as per the approved list of makes. The installation shall be carried out with an installer certified / recommended by the manufacturer. The Contractor shall submit shop drawings for approval of Engineer-in-charge before commencement of works on site.

Mode of measurement: - The payment shall be made based on the installed areaand shall include the cost of all operations as specified above. The quoted rates shall include cost of all material, all hardware's, fixtures, Glass, framework,anchorage, labor, workmanship, tools, plants, scaffolding, hardware etc. for working at all heights and levels

MMRDA

SECTION – C

FLOORING & FLOOR FINISHES

1. Vinyl Flooring:

a) Providing and fixing of 3-3.35mm thick acoustic multi-layered vinyl floorcovering of size 2 Mtrs. width having total weight 2825 g/m2 comprises a Very High Density (VHD) foam backing reinforced with a glass fibre and a printed design that is protected by a transparent wear layer thickness of 0.65mm treated with UV laser cross-linking surface treatment which facilitates ease of maintenance and eliminates the use of acrylic emulsions.

b) The product should have antistatic properties (AS Class 1) having antibacterial and fungicidal treatment. The product should have excellent sound insulation with impact sound insulation of 19dB and excellent shock absorbent behaviour. The laid flooring shall confirm thefire rating Bfl-s1 class as per EN 13501-1.

c) The floor should have extreme durability (Group 'T') rating as per NF- 189 having wear resistance of ≤2.0mm3 as per EN 660.2 and should have a residual indentation of ≤0.20mm confirming to ISO 24343-1 (EN- 433).

d) It should have low VOC contain as TVOC after 28 days <10 µg/m3 asper ISO 16000-6.

e) The work shall be carried out as per manufacture specification.

f) The floor finish should terminate at the room perimeter passing over aconcealed cove former and continuing up the wall for 100mm.

g) The joints in the flooring should be sealed by using a PVC welding barof matching colour to be supplied by the manufacturer, using a hot air gun for fusion of welding bar with flooring.

h) The vinyl sheet shall be laid & fixed with water-based adhesive of approved make as per manufacturer's specification as per direction and the entire satisfaction of Engineer-in-charge.

i) The responsibility of the evenness of the base strata lies solely with the Contractor.

Mode of measurement

Length & breadth of the finished shall be measured correct to a centimeter. The area shall be calculated in square meter correct to two decimal places. The plan areas shall only be considered for payments and overlaps, projection on wall and wastages should be considered in the quoted rates. Rates shall include the cost ofall operations as listed above including all materials, tools, plant, labour, foam backing reinforced with glass fiber, PVC weld bar, hot fusion welding, adhesives etc. at all heights and levels.

2. Engineered Wood Flooring

a) Providing and supplying Engineered Wood Flooring, of approved makecolour & shade with square edges

b) Planks size of 14-15mm thick with 3-3.5mm top Lamella,

c) 135-190mm wide and 1800-2190 mm length with special 5G locking system.

d) The top 3.5mm Lamella shall be impregnated with 6 Coats of UV Acrylic

80gm/M2/Hard wax oil finish and with Brush Finish to enhance the surface hardness.

e) Fire rating as per EN1350-1, formaldehyde emission according to EN 717-1 certified as Class-1

f) The Engineered hardwood should be a completely floating floor (using a Polythene sheet as a moisture barrier of minimum of 250 microns and 2mm expandable foam).

g) The application should be with 5G click system by the trained and certified professional by the manufacturer. The installation shall be undertaken as per the manufacturer's installation instructions.

h) The responsibility of the evenness of the base strata lies solely with the Contractor.

Mode of measurement

Length & breadth of the finished shall be measured correct to a centimeter. The area shall be calculated in square meter correct to two decimal places. The plan areas shall only be considered for payments and profiles, skirting and wastages should be considered in the quoted rates. Rates shall include the cost of all operations as listed above including all materials, tools, plant, labour, 5G click system, expandable foam and polythene sheet etc. at all heights and levels.

3. **Laminated Wooden Flooring**

a) Providing and laying 8mm thick Laminated wooden flooring AC-4 grade of approved make, colour, shade and patterns in approved plank sizes.

b) The installation shall be carried out as per manufacturersrecommendations over 2-3mm thick approved underlay material.

c) The responsibility of the evenness of the base strata lies solely with the Contractor.

Mode of measurement

Length & breadth of the finished shall be measured correct to a centimeter. The area shall be calculated in square meter correct to two decimal places. The plan areas shall only be considered for payments and profiles, skirting and wastages should be considered in the quoted rates. Rates shall include the cost of all operations as listed above including all materials, tools, plant, labour, underlay etc.at all heights and levels.

4. **Carpet Flooring:**

a. Carpet floor covering rolls of Colours series having a density of 70 million fibres of nylon 6.6 per M2, Fire Test EN-13501, Appearance Retention Hexapod ISO 140-8, Friction Slip Resistance Test EN 14041 Class DS, sanitized anti-microbial treatment with resilient waterproof backing.

b. The flooring should be Anti-static with thickness of 4.3 mm and approximate weight of 1.8 kilogram per square meter of roll form.

c. Total Thickness as per ISO 1765: 4.3 mm Roll width: 2.0 M Roll length: 30M Dimensional stability as per ISO 2551: <0.2% Slip Resistance as per DIN 51097: >0.7 Dry and Wet.

d. The floor covering should have Fire Test EN-13501, Appearance RetentionHexapod

ISO 140-8, Friction Slip Resistance Test EN 14041 Class DS, SANITISED anti-microbial treatment, with resilient waterproof backing, anti- allergic which is certified by British allergy foundation, with ten year replacement guarantee passed on back to back to the Client.

e. Total weight as per ISO 8543: 1.8 kg/M2 Light fastness as per EN ISO 105B02: 6 Commercial heavy as per EN 685: Class 33 Reaction to fire as perEN 13501-1 : Bfl-s1.

f. The responsibility of the evenness of the base strata lies solely with the Contractor.

Mode of measurement:

The rates shall be inclusive of all operations as specified above including all laborand workmanship, material, aluminum profiles, protection, adhesives etc. at all heights and levels.

5. PU Flooring

Providing and applying Flooring for areas as specified in drawings or directed byengineer-in-charge (High Performance Polyurethane Coating)

a) Surface Preparation

The cleaning and preparation of the substrate to which the system is applied must be carried out thoroughly to leave a sound base for the application. Any laitance present on the surface must be removed mechanically. Release oil and other contaminants which may impair adhesion must be removed prior to the application of the primer. Minor repair shall be done by repair range of products.

b) Primer

The primer shall be a two-component solvent free epoxy surface sealer and primer for concrete substrate. The primer shall form effective bond on the substrate. The primer shall exhibit excellent bond strength greater than the cohesive strength of good concrete of minimum M30 Grade as per ASTM D 4541 testing.

c) Sand Broadcasting

Oven dried, graded sand is immediately and evenly spread over the entire wetsurface by hand or mechanically @ 0.6 Kg/sqm depending on application, when sufficiently cured the surface is vacuumed to remove any loose sand.

d) Waterproofing cum wearing coat:

Providing and applying 1 layer of Topcoat of PU waterproofing at 0.7 kg/sqm/layer (A two component solvent free polyurethane coating to provide crack bridging and waterproofing capability.

e) Intermediate Coat

Providing and applying 1 layer of Topcoat at a coverage of 0.8 kg/sqm/layer (asolvent free, two component high abrasion and chemical/oil resistant elastomeric pigmented polyurethane coating)

f) Topcoat

Providing and applying 1 layer of Topcoat at a coverage of 0.4 kg/sqm/layer (asolvent free, two component low viscosity, high abrasion and chemical/oil resistant pigmented polyurethane coating)

The responsibility of the evenness of the base strata lies solely with the Contractor.

Mode of measurement

The rates shall be inclusive of all operations as specified above including all laborand workmanship, material, adhesives etc. at all heights and levels.

6. Terracotta Flooring

[A] Material: -

The works shall comprise of providing and laying Terracotta Floor tiles of 300x 300 x 12 mm in size of approved manufacturer and pattern. The work shall be followed as per the Drawings or as per the Engineer-n-charge. The tolerance of tile acceptable with +/- 2mm in length/ breadth. Terracotta flooring tiles Should have a maximum of 12% water absorption.

[B] Workmanship

g. Terracotta Floor tiles should be approved make with no harmful substances.
h. The entire surface shall to be cleaned and all loose particles and dust,oil and grease is to be removed before commencement of work.
i. The floor shall be over the mortar of cement and sand thoroughly mixed inratio of as specified or as directed by the Engineer-in-charge
j. Terracotta Floor Tiles must be laid with a minimum of 3 mm space between tiles.
k. The space in between the tiles is filled later with a paste of white cementmixed with approved pigment as per drawing and as directed by the Engineer-in-charge
l. Cleaning excess joint filler while filling without letting it get dried.
m. Mild acid wash can be done to clean terracotta tiles to clean thoughstains, if needed
n. The finished Flooring shall be properly covered and protected till finalhandover to the Client.
o. The responsibility of the evenness of the base strata lies solelywith the Contractor.

Mode of Measurement - Length and breadth shall be measured before laying skirting, dado or wall plaster. No deduction shall be made nor extra paid for voidsnot exceeding 0.20 sqm. Deductions for ends of dissimilar materials or other articles embeddedshall not be made for areas not exceeding 0.10 sqm. Rates shall be inclusive of alloperations as listed above as indicated in drawings, all joint Grouting, Cement Mortar, wastages, Cleaning / dusting as desired by the Engineer, preparation of templates including all tools, plants, hardware, supporting systems, machinery etc.at all heights and levels.

7. Stone Sealer

[A] Stone Sealer shall be applied Over the top surface of the granite flooring asindicated in drawings and as directed by the Engineer as per the following specifications

a. Specific Gravity of Sealer should be 0.87 Kg per Litre
b. Minimum two coat of Sealer shall be applied over Application area
c. Spread rates- wet: 100-150 micron

Dry: 60-75 microns

Properties

a. Nano technology-based impregnator

b. Excellent Hydrophobic Properties

c. Highly resistant to water based staining damages

d. U V resistant

[B] Application

a. Remove loose particles, cement-based materials and dust from the surfaces to be sealed with Approved sealer as the directed by the Engineer.

b. Clean the surface with clean water and allow the surface to completely dry.

c. Apply Sealer uniformly over the surface till it is damp using a clean white cloth or paint brush or as per directed by the engineer.

d. The cleaning should be done, using white cotton cloth by pressing the clothon the applied surface and buffing the area in circular motion, before the liquid dries on the surface.

e. Multiple applications may be required for some area as directed by the Engineer. In case of multiple applications, allow 6 to 12 hours gap betweenthe applications.

f. The Contractor shall be responsible to protecting the metal surfaces, woodsurfaces with suitable protection covers to avoid contact with the sealer.

g. Sealer should not be applied on the dry surface

h. All the Precautions shall be Followed by the Contractor as Following

1. First three days - Do not use the surface at all.
2. Days 4 to 7 - Light use is permitted, but keep all liquids off the surface as they will penetrate the surface and cause blistering
3. Day 8 and beyond - Moisture and dirt should not be left on the surface for longer than 8 hours. Use a soft cloth and warm waterto clean up spills and water and do not use abrasive cleaners orscouring pad

Mode of measurement:- The Quantity of Stone Sealer shall be measured on thebasis of area of application and shall include all operations as listed above including Cleaning, Rubbing, as per indicated in drawings, preparation of templates including all tools, plants, hardware, supporting systems, etc. at all heights and levels. The Stone Sealer carry a guarantee for a period of 5 years which shall be passed on back to back in the name of the Client.

MMRDA

SECTION – D ROOFING Work

1.0 Metal Ceiling

1.1 MATERIAL

Providing and fixing perforated Clip in swing down metal ceiling system, clip in system with swing down, 304 Alloy 0.5 mm Stainless steel. Finish of ceiling tiles, supported by clip in profile made of galvanized steel 0.60 mmand the suspension channel connector made of galvanized 0.60 mm steel@ 1200 c/c for clip in ceiling, length 100 mm along with hanger lower section for suspension channel, hanger upper section for available ceiling void, including safety pin, self-tapping screws etc., To meet 'CLASS-O' fire propagation, as approved by the Engineer-in- Charge. (a) 600 X 600 MM TILES. Metal ceiling panels according to EN 13964 and quality standards of TAIM e.V.: latest version.

1.2 APPROVED SYSTEM

Providing and fixing perforated Clip in swing down metal ceiling system, clipin system with swing down, 304 Alloy 0.5 mm Stainless steel. Finish of ceiling tiles, supported by clip in profile made of galvanized steel 0.60 mmand the suspension channel connector made of galvanized 0.60 mm steel@ 1200 c/c for clip in ceiling, length 100 mm along with hanger lower section for suspension channel, hanger upper section for available ceiling void, including safety pin, self-tapping screws etc., To meet 'CLASS-O' fire propagation, as approved by the Engineer-in- Charge. (a) 600 X 600 MM TILES. Metal ceiling panels according to EN 13964 and quality standards of TAIM e.V.: latest version.

Metal ceiling panels according to EN 13964 and quality standards of TAIMe.V.: latest version. The metal ceiling system, powder coating and acousticin lays should be according to building material class A2-s1, d0 as per EN13501-1 & Class A (IBC) as per ASTM E 84. Durability of the ceiling system according to EN 13964, tables 8 & 9. Exposure class A. The suspension channel of length 4000 mm made up of 0.6 mm thick galvanized steel, along with M6 Bracket section for suspension channel, M6 Threaded rod with Fastener approved by the Engineering- Charge

1.3 ACCESS

All the ceiling panels must be able to open by opening mechanism, the metal ceiling panel should be having serviceability advantage by having removable

1.4 LEVEL

All the panels should be fitted to ensure accurate positioning & level of theceiling system as per the site/architectural requirements. The Curve bendplain panels will form the ceiling in curve as per the roof ceiling level.

1.5 GENERAL SUSPENSION SYSTEM

The suspension channel connector made of galvanized 0.60 mm steel @ 1200 c/c for clip in ceiling, length 100 mm along with hanger lower section for suspension

channel, hanger upper section for available ceiling void, including safety pin, self-tapping screws etc., To meet 'CLASS-O' fire propagation, as approved by the Engineer-in-Charge. (a) 600 X 600 MM TILES. Metal ceiling panels according to EN 13964 and quality standards of TAIM e.V.: latest version. The metal ceiling system, powder coating and acoustic in lays should be according to building material class A2-s1, d0 asper EN 13501-1 & Class A (IBC) as per ASTM E 84. Durability of the ceilingsystem according to EN 13964, tables 8 & 9. Exposure class A along with M6 Bracket section for suspension channel, M6 Threaded rod with Fastener approved by the Engineering- Charge The panels shall be fixed to pre-install structural M.S. frame / RCC work at all levels including all accessories like fasteners, hangers, screws, washers, etc. conforming to specificationsand directions of Engineer-in-Charge.

1.6 FINISH

Surface of the panels to be Stainless steel of grade 304 Alloy. The metal ceiling system, powder coating and acoustic in lays should be according tobuilding material class A2-s1, d0 as per EN 13501-1 & Class A (IBC) as perASTM E 84. Durability of the ceiling system according to EN 13964, tables8 & 9. Exposure class A. The system to have Cradle-to-Cradle® Silver certification.

1.7 FIRE PERFORMANCE

The system should be in accordance with Material class A2-s1, d0 according to EN 13501-1 "non-combustible. The metal ceiling system, powder coating and acoustic in lays should be according to building material class A2-s1, d0 as per EN 13501-1 & Class A (IBC) as per ASTM E 84. Durability of theceiling system according to EN 13964, tables 8 & 9. Exposure class A. Thesystem to have Cradle-to-Cradle® Silver certification.

1.8 PROVISIONS FOR LIGHT AND OTHER FITTINGS

The panels will be cut on site for the provision of light fixtures and other fittings as per the directions of the Engineer In charge

1.9 MANUFACTURING TOLERANCES

All the metal ceiling elements and the corresponding substructure should be manufactured in accordance with ceiling standards accessed by EN 13964& TAIM (Federation of Industrial Metal Ceiling Manufacturers). Metal ceiling panels according to EN 13964 and quality standards of TAIM e.V.: latest version.

1.10 GREEN BUILDING

The metal ceiling systems should be applicable for certifications in accordance to LEED & DGNB, Environmental product decelerations (EPD)to be submitted when ever asked. The system to have Cradle-to-Cradle® Silver certification.

1.11 QUALITY ASSURANCE

- DIN ISO 9001 for general quality management system
- LEED & DGNB for green building product.

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- EN 13964 for ceiling standard as per EN
- EN 13501-1 building material class A2-s1, d0

1.12 WARRANTY CERTIFICATE

Manufacturer should submit the warranty certificate for the minimum 15 years.

1.13 MEASUREMENT

Length & breadth of the finished ceiling shall be measured correct to a centimeter. The area shall be calculated in square meter correct to two decimal places. No deduction shall be made for making openings for electrical, air conditioning, firefighting fixtures nor shall extra payment be made either for extra materials or labour in making such openings. The Items includes supplying, Installation and fixing of metal ceiling system over MS structural frame / RCC work, Labours, Scaffolding all required machineries for fixing tools, Fasteners, Hangers, screws, washers, etc. allcomplete at all levels. The system should be in accordance with Material class A2-s1, d0 according to EN 13501-1 "non-combustible". approved by the Engineering- Charge.

2.0 Torsion spring metal ceiling

2.1 MATERIAL

Torsion spring metal ceiling system, 600X 600 X 0.6 mm GMS. Finish of ceiling tiles should be of special polyester powder coated RAL 9010perforated with round holes of 1.8 mm diameter arranged in diagonal pitchat 60 degrees with horizontal center distance of 3.32 mm and vertical center distance of 3.83 mm, 20% open area and with acoustic felt at the back to achieve minimum NRC 0.7 and SAA equal to 0.77 tested in a reverberationroom in accordance to ISO 354 type E-200 and rated to ASTM C 423 andISO 11654. Surface of the panels to be polyester powder coated with minimum 80 microns in RAL 9010 colour, light reflectance approx. 82% according to DIN 5033 supported by clip in profile made of galvanized steel
0.60 mm and the suspension channel connector made of galvanized 0.60mm steel @ 1200 c/c for clip in swing down ceiling, length 100 mm along with hanger lower section for suspension channel, hanger upper section for available ceiling void, including safety pin, self-tapping screws etc., To meet 'CLASS-O' fire propagation, as approved by the Engineer-in-Charge. (a) 600 X 600 MM TILES

APPROVED SYSTEM

Perforated Torsion spring metal ceiling system, 600X 600 X 0.6 mm GMS.Finish of ceiling tiles should be of special polyester powder coated RAL 9010 perforated with round holes of 1.8 mm diameter arranged in diagonal pitch at 60 degrees with horizontal center distance of 3.32 mm and vertical center distance of 3.83 mm, 20% open area and with acoustic felt at the back to achieve minimum NRC
0.7 and SAA equal to 0.77 tested in a reverberation room in accordance toISO 354 type E-200 and rated to ASTM C 423 and ISO 11654. Surface ofthe panels to be polyester powder coated with minimum 80 microns in RAL 9010 Colour, light reflectance approx. 82% according to DIN 5033
.Supported by clip in profile made of galvanized steel 0.60 mm and the suspension channel connector made of galvanized 0.60 mm steel @ 1200c/c for clip in swing

down ceiling, length 100 mm along with hanger lower section for suspension channel, hanger upper section for available ceilingvoid, including safety pin, self-tapping screws etc., To meet 'CLASS-O' fire propagation, as approved by the Engineer-in-Charge. (a) 600 X 600 MM TILES, M6 Threaded rod with Fastener approved by the Engineering- Charge The panels shall be fixed to pre-install structural M.S. frame

/ RCC work at all levels including all accessories like fasteners, hangers, screws, washers, etc. conforming to specifications and directions of Engineer-in-Charge. Contractor shall give 10 years guarantee for entire system including polyester powder coating.

Metal ceiling panels according to EN 13964 and quality standards of TAIMe.V.: latest version. The metal ceiling system, powder coating and acousticin lays should be according to building material class A2-s1, d0 as per EN13501-1 & Class A (IBC) as per ASTM E 84. Durability of the ceiling system according to EN 13964, tables 8 & 9. Exposure class A. The system to have Cradle-to-Cradle® Silver certification. The suspension channel of length 4000 mm made up of 0.6 mm thick galvanized steel, along with M6 Bracket section for suspension channel, M6 Threaded rod with Fastener approvedby the Engineering- Charge

2.3 ACCESS

All the ceiling panels must be able to open by opening mechanism, the metal ceiling panel should be having serviceability advantage by having removable

2.4 LEVEL

All the panels should be fitted to ensure accurate positioning & level of theceiling system as per the site/architectural requirements. The Curve bendplain panels will form the ceiling in curve as per the roof ceiling level.

2.5 GENERAL SUSPENSION SYSTEM

The suspension channel connector made of galvanized 0.60 mm steel @1200 c/c for clip in ceiling, length 100 mm along with hanger lower section for suspension channel, hanger upper section for available ceiling void, including safety pin, self-tapping screws etc., To meet 'CLASS-O' fire propagation, as approved by the Engineer-in-Charge. (a) 600 X 600 MM TILES. Metal ceiling panels according to EN 13964 and quality standards of TAIM e.V.: latest version. The metal ceiling system, powder coating and acoustic in lays should be according to building material class A2-s1, d0 as per EN 13501-1 & Class A (IBC) as per ASTM E 84. Durability of the ceiling system according to EN 13964, tables

8 & 9. Exposure class A. The system to have Cradle-to-Cradle® Silver certification. along with M6 Bracket section for suspension channel, M6 Threaded rod with Fastener approved by the Engineering- Charge The panels shall be fixed to pre-install structural M.S. frame / RCC work at all levels including all accessories like fasteners, hangers, screws, washers, etc. conforming to specifications and directions of Engineer-in-Charge.

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2.6 FINISH

Surface of the panels to be polyester powder coated with minimum 80 microns in RAL 9010 Colour, light reflectance approx. 82% according to DIN 5033.The metal ceiling system, powder coating and acoustic in lays shouldbe according to building material class A2-s1, d0 as per EN 13501-1 & Class A (IBC) as per ASTM E 84. Durability of the ceiling system according to EN13964, tables 8 & 9. Exposure class A.

2.7 FIRE PERFORMANCE

The system should be in accordance with Material class A2-s1, d0 accordingto EN 13501-1 "non-combustible. The metal ceiling system, powder coating and acoustic in lays should be according to building material class A2-s1, d0 as per EN 13501-1 & Class A (IBC) as per ASTM E 84. Durability of theceiling system according to EN 13964, tables 8 & 9. Exposure class A.

2.8 PROVISIONS FOR LIGHT AND OTHER FITTINGS

The panels will be cut on site for the provision of light fixtures and other fittings as per the directions of the Engineer In charge

2.9 MANUFACTURING TOLERANCES

All the metal ceiling elements and the corresponding substructure should be manufactured in accordance with ceiling standards accessed by EN 13964& TAIM (Federation of Industrial Metal Ceiling Manufacturers). Metal ceiling panels according to EN 13964 and quality standards of TAIM e.V.: latest version.

2.10 GREEN BUILDING

The metal ceiling systems should be applicable for certifications in accordance to LEED & DGNB, Environmental product decelerations (EPD)to be submitted when ever asked. The system to have Cradle-to-Cradle® Silver certification.

2.11 QUALITY ASSURANCE

- DIN ISO 9001 for general quality management system
- LEED & DGNB for green building product.
- EN 13964 for ceiling standard as per EN
- EN 13501-1 building material class A2-s1, d0

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2.12 WARRANTY CERTIFICATE

Manufacturer should submit the warranty certificate for the minimum 15 years.

2.13 MEASUREMENT

Length & breadth of the finished ceiling shall be measured correct to a centimeter. The area shall be calculated in square meter correct to two decimal places. No deduction shall be made for making openings for electrical, air conditioning, firefighting fixtures nor shall extra payment be made either for extra materials or labour in making such openings. The Items includes supplying, Installation and fixing of metal ceiling system over MS structural frame / RCC work, Labours, Scaffolding

all required machineries for fixing tools, Fasteners, Hangers, screws, washers, etc. allcomplete at all levels.

3.0 Open Cell Ceiling MATERIAL

Profiles 10mm wide x 50mm deep x 0.5mm thick with inwardly returned edges of 2.5mm.Coil Coated on a Continuous Paint Line, Double baked and Roll formed from enameled

Corrosion Resistance Aluminum Alloy (Al.Mg) for higher strength and good Roll Forming characteristics

APPROVED SYSTEM

Providing and fixing Open ceiling system made up of aluminum , of approved Colour consisting of Main Runner, Cross Runner, Upper Sections, Lower Sections all of U-Shaped Profiles 10mm wide x 50mm deep x 0.5mm thickwith inwardly returned edges of 2.5mm. Coil Coated on a Continuous PaintLine, Double baked and Roll formed from enameled Corrosion ResistanceAluminum Alloy (Al.Mg) for higher strength and good Roll Forming characteristics. The Main Runner shall be fixed at 1.2mtrs c/c and shall besuspended by means of G.I. Suspension Rod 4mm diameter and a Galvanized Suspension Spring Clip at 1.2mtr c/c. The Cross-Runner shallbe fixed to the Main Runner at a distance 0.6mtrs c/c., with a self-locking device. The Upper Section and Lower section shall be fixed to the Main Runner and Cross Runner in a form of a Cell Structure of module 50mm x50mm/ 75mm x 75mm/100mm x 100mm with a self- locking device. Paint Finish: - Aluminum Main Runners Cross Runners Upper Section, Lower Section of U-Shaped Profiles shall be chromatised for maximum bond between metal and paint, enameled twice under high temperature one sidewith full primer and Finish Coat, the other side (inner side) with a Primer Coating and Skin Coat on a Continues Paint Line. Mode of Measurements:

- Measurements shall be wall to wall without deductions for lights, diffusers,columns etc.

Module: -100 mm X 100 mm and 75mmX 75mm

ACCESS

All the ceiling panels must be able to open by torsion spring mechanism, the metal ceiling panel should be having serviceability advantage by having removable

LEVEL

All the panels should be fitted to ensure accurate positioning & level of theceiling system as per the site/architectural requirements. The Curve bendplain panels will form the ceiling in curve as per the roof ceiling level.

GENERAL SUSPENSION SYSTEM

The Main Runner shall be fixed at 1.2mtrs c/c and shall be suspended by means of G.I. Suspension Rod 4mm diameter and a Galvanized Suspension Spring Clip at 1.2mtr c/c. The Cross-Runner shall be fixed to the Main Runner at a distance

0.6mtrs c/c., with a self-locking device. The Upper Section and Lower section shall be fixed to the Main Runner and Cross Runner in a form of a Cell Structure of module 50mm x 50mm/ 75mm x 75mm/100mm x 100mm with a self-locking device. Paint Finish: - Aluminum Main Runners Cross Runners Upper Section, Lower Section of U-Shaped Profiles shall be chromatised for maximum bond between metal

FINISH

Surface of the panels to be polyester powder coated with minimum 80 microns in RAL 9010 Colour, light reflectance approx. 82% according to DIN 5033.Pre painted products will not be permitted. The powder coatingprocess should be flat powder coating plant and no vertical hanging powder line will be allowed for electrostatically applied powder coating process. The metal ceiling system, powder coating and acoustic in lays should beaccording to building material class A2-s1, d0 as per EN 13501-1 & Class A (IBC) as per ASTM E 84. Durability of the ceiling system according to EN 13964, tables 8 & 9. Exposure class A.

FIRE PERFORMANCE

The system should be in accordance with Material class A2-s1, d0 according to EN 13501-1 "non-combustible. The metal ceiling system, powder coating and acoustic in lays should be according to building material class A2-s1, d0 as per EN 13501-1 & Class A (IBC) as per ASTM E 84. Durability of theceiling system according to EN 13964, tables 8 & 9. Exposure class A.

PROVISIONS FOR LIGHT AND OTHER FITTINGS

The panels will be cut on site for the provision of light fixtures and other fittings as per the directions of the Engineer In charge

MANUFACTURING TOLERANCES

All the metal ceiling elements and the corresponding substructure should be manufactured in accordance with ceiling standards accessed by EN 13964& TAIM (Federation of Industrial Metal Ceiling Manufacturers). Metal ceiling panels according to EN 13964 and quality standards of TAIM e.V.: latest version.

GREEN BUILDING

The metal ceiling systems should be applicable for certifications in accordance to LEED & DGNB, Environmental product decelerations (EPD)to be submitted when ever asked.

QUALITY ASSURANCE

- DIN ISO 9001 for general quality management system
- LEED & DGNB for green building product.
- EN 13964 for ceiling standard as per EN
- EN 13501-1 building material class A2-s1, d0WARRANTY CERTIFICATE

Manufacturer should submit the warranty certificate for the minimum 15 years.

MEASUREMENT

Length & breadth of the finished ceiling shall be measured correct to a centimeter. The area shall be calculated in square meter correct to two decimal places. No deduction shall be made for making openings for electrical, air conditioning, firefighting fixtures nor shall extra payment be made either for extra materials or labour in making such openings. The Items includes supplying, Installation and fixing of metal ceiling system over MS structural frame / RCC work, Labours, Scaffolding all required machineries for fixing tools, Fasteners, Hangers, screws, washers, etc. allcomplete at all levels.

4.0 Bamboo Ceiling

Providing & fixing of bamboo grid ceiling with backer made of natural bamboo with 24 mm prelude on black exposed T grid. The bamboo grill panel module of nominal size 35X300X2400 mm comprising of 8 blades of35 X 16X2376 mm with on center spacing of 37.5 mm fixed through backerof size 12X22X300 mm with on center spacing of 300 mm and additional end dowels at 150 mm from both the edges. Ledger of 6.5X2.4X2400 mmto be used for covering face of wall angle. The panels should be lacquered,and UV coated to natural shade of choice of architect as per approved sample. The panel should be fire rated as per ASTM E 84 and toxicity as per ASTM E 1678.The bamboo using a vacuum press with the 2.5% Decametric/Deltamethrin Suspension Dose preservative. The anti-termite preservative 2.5% Decametric/Deltamethrin Suspension Dose has been proven as suitable anti-termite treatment to be applied on wood and bamboo. This preservative protects the product against the termite speciesCopt Termes sp. and Reticulitermes sp. The bamboo products should contribute to various credits for LEED: - Contribution LEED BD+C –v4: SS7, MR1, MR2, EQ2, MR3 (FSC)
V2009: MR6, MR7 (FSC), IEQ4.3, IEQ 4.4 (if requested as E0. The grid should be approved make as manufacturer recommendation.

Installation: To comprise main runner spaced at 1200 mm center securelyfixed to the structural soffit using suspension system at 1200 mm maximum center. The suspension system at the end of each main runner should notbe greater than 450 mm from adjacent wall.

Flush fitting 1200 mm long cross tee to be interlocked between main runners at 600 mm center to form 1200 X 600 mm module. Cut cross tee longer than 600 mm required independent support. The Items includes supplying, Installation and fixing of metal ceiling system over MS structural frame / RCC work, Labors, Scaffolding all required machineries for fixing tools, Fasteners, Hangers, screws, washers, etc. The system should be inaccordance with Material class A2-s1, d0 according to EN 13501-1 "non- combustible". Approved by the Engineering- Charge

LEVEL

All the panels should be fitted to ensure accurate positioning & level of the

ceiling system as per the site/architectural requirements. The Curve bend plain panels will form the ceiling in curve as per the roof ceiling level.

GENERAL SUSPENSION SYSTEM

The Main should be approved make as manufacturer recommendation. Installation: To comprise main runner spaced at 1200 mm center securelyfixed to the structural soffit using suspension system at 1200 mm maximum center. The suspension system at the end of each main runner should not be greater than 450 mm from adjacent wall.

Flush fitting 1200 mm long cross tee to be interlocked between main runners at 600 mm center to form 1200 X 600 mm module. Cut cross tee longer than 600mm required independent support. The Items includes supplying, Installation and fixing of metal ceiling system overMS structural frame / RCC work, Labors, Scaffolding all required machineries for fixing tools, Fasteners, Hangers, screws, washers, etc. The system should be in accordance with Material class A2-s1, d0 according to EN 13501-1 "non-combustible". Approved by the Engineering- Charge. Make/Model No. Lindner, Armstrong, Moso

FINISH

Surface of the bamboo panels should be lacquered, and UV coated to natural shade of choice of architect as per approved sample. The panel should be fire rated as per ASTM E 84 and toxicity as per ASTM E 1678.The bamboo using a vacuum press with the 2.5% Decametric/Deltamethrin Suspension Dose preservative. The anti-termite preservative 2.5% Decametric/Deltamethrin Suspension Dose has been proven as suitable anti-termite treatment to be applied on wood and bamboo. This preservative protects the product against the termite species Copt Termes sp. and Reticulitermes sp.

FIRE PERFORMANCE

The system should be in accordance with ASTM E 84.

PROVISIONS FOR LIGHT AND OTHER FITTINGS

The panels will be cut on site for the provision of light fixtures and other fittings as per the directions of the Engineer In charge

MANUFACTURING TOLERANCES

All the metal ceiling elements and the corresponding substructure should be manufactured in accordance with ceiling standards accessed by EN 13964& TAIM (Federation of Industrial Metal Ceiling Manufacturers). Metal ceiling panels according to EN 13964 and quality standards of TAIM e.V.: latest version.

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GREEN BUILDING

The metal ceiling systems should be applicable for certifications in accordance to LEED & DGNB, Environmental product decelerations (EPD)to be submitted when ever asked. The system to have Cradle-to-Cradle® Silver certification.

QUALITY ASSURANCE

- DIN ISO 9001 for general quality management system
- LEED & DGNB for green building product.
- EN 13964 for ceiling standard as per EN
- EN 13501-1 building material class A2-s1, d0WARRANTY CERTIFICATE

Manufacturer should submit the warranty certificate for the minimum 10 years.

MEASUREMENT

Length & breadth of the finished ceiling shall be measured correct to a centimeter. The area shall be calculated in square meter correct to two decimal places. No deduction shall be made for making openings for electrical, air conditioning, fire fighting fixtures nor shall extra payment be made either for extra materialsor labor in making such openings. The Items includes supplying, Installation and fixing of ceiling system with necessary framework as specified above including Labors, Scaffolding all required machineries for fixing tools,Fasteners, Hangers, screws, washers, etc. all complete at all levels.

5.0 Baffle Ceiling

a) U Baffle Aluminium panel ceiling of approved colour consisting of panelsize 100 / 50 mm deep X 50mm width using 0.5/0.6mm thick, panel length up to 4 mtr, Coil Coated on a Continuous Paint Line, Double baked and roll formed from enamelled corrosion resistance Aluminiumalloy AA 3005 (Al. Mg) for higher strength and good roll formingcharacteristics.

b) Panels shall be clipped to a baked enamelled Aluminium carrier of 30 mm wide x 47 mm high x 0.5 mm thick, Black Colour coated, one leg ofthe carriers with cut outs to hold the panels in a module of 100 / 200 mm.

c) Panel carrier shall be suspended by means of threaded rod at a distance of 1.8 mtr c/c. Paint Finish:

d) Aluminium panels shall be chromatised for maximum bond betweenmetal and paint enamelled twice under high temperature,

e) Exposed side with a full primer and finish coat on a ContinuousPaint Line. Ceiling Finish above U Baffle Ceiling:

f) Ceiling area above U Baffle to be painted in black colour beforefixing this system

Mode of measurement: - Length & breadth of the finished ceiling shall be measured correct to a centimeter. The areashall be calculated in square meter correct to two decimal places. No deduction shall be made for making openings for electrical, air conditioning, firefighting fixtures nor shall extrapayment be made either for extra materials or labor in making such openings. The Items includes supplying, Installation and fixing of ceiling system with necessary framework as specified above with painting of ceiling surface as specified including Labors, Scaffolding all required machineries,

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for fixing tools,Fasteners, Hangers, screws, washers, etc. all complete at all levels.

6.0 (Multi B) Metal ceiling

a) Un-perforated, Ceiling System with V closed groove consisting of panel 30 mm wide x15mm deep x 0.4mm thick with square edges, panelling up to 6 mtrs, Coil Coated on a Continuous Paint Line, Double baked and roll formed from enamelled corrosion resistance Aluminium Alloy AA5050 (Al.Mg) for higherstrength and good roll forming characteristics.

b) Panel shall be clipped to baked enamelled Aluminium panel carrier of 62mm wide x29mm deep made of 0.95mm thick in standard length of 5mtrs made of double baked enamelled Aluminium alloy AA5050(Al.Mg.) black with cut- outs to hold the panels in a module of 50mm (width of gap 20mm open)

c) The Carrier shall be suspended by means of G.I. suspensionrod 4mm diameter, and a Galvanised suspension spring clip at 1.7mtrs c/c.

d) Paint finish: Aluminium panels shall be chromatised formaximum bond between metal and paint enamelled twice underhigh temperature, one side with full primer and finish coat, the other side (inner side) with a primer coating and Skin Coat on a Continuous Paint Line.

Mode of measurement: - Length & breadth of the finished ceiling shall bemeasured correct to a centimeter. The area shallbe calculated in square meter correct to two decimal places. Nodeduction shall be made for making openings for electrical, air conditioning, firefighting fixtures nor shall extra payment bemade either for extra materials or labor in making such openings. The Items includes supplying, Installation and fixingof ceiling system with necessary framework as specified above including Labors, Scaffolding all required machineries for fixing tools, Fasteners, Hangers, screws, washers, etc. all completeat all levels.

7.0 Perforated Metal ceiling

a) Aluminium, perforated Ceiling System with V closed groove consisting of panel 30mm wide x 15mm deep x 0.4mm thick with square edges, panel length up to 6 mtrs, Coil Coated on a Continuous Paint Line, Double baked and roll formed from enamelled corrosion resistance Aluminium Alloy AA 5050 (Al. Mg) for higher strength and good roll forming characteristics.

b) Panel shall be clipped to baked enamelled Aluminium panel carrier of 62mm wide x 29mm deep made of 0.95mm thick in standard length of 5mtrs made of double baked enamelled Aluminium alloy AA 5050 (Al. Mg.) black with cut outs to hold the panels in a module of 50mm (width of gap 20mm open)

c) The Carrier shall be suspended by means of G.I. suspension rod 4mm diameter, and a Galvanised suspension spring clip ata distance of 1.7mtrsc/c. Paint finish: Aluminium panels shall bechromatised for maximum bond between metal and paint enamelled twice under high temperature, one side with full primer and finish coat, the other side (inner side) with a primer coating and Skin Coat on a Continuous Paint Line.

Mode of measurement: - Length & breadth of the finished ceiling shall be measured

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correct to a centimeter. The areashall be calculated in square meter correct to two decimal places. No deduction shall be made for making openings for electrical, air conditioning, firefighting fixtures nor shall extra payment be made either for extra materials or labor in making such openings. The Items includes supplying, Installation and fixing of ceiling system with necessary framework as specified above including Labors, Scaffolding all required machineries for fixing tools, Fasteners, Hangers, screws, washers, etc. all complete at all levels.

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SECTION – E

Water Proofing Work

1. RAFT SLAB WATERPROOFING SYSTEM

Supplying and installing 1.2mm thick self-adhesive HDPE membrane, having puncture resistance of 1000N (as per ASTM E 154) and hydrostatic head resistance not less than 60m head of water (ASTM D 5385).The system should be fully bonded to the RCC and consists of highly resilient HDPE film, a pressure sensitive - adhesive layer which is covered by a weather proof protective layer .The membraneshall haveminimum of 75mm side and end laps which shall be sealed with doublesided adhesive tape. The size of the membrane should not be lessthan 2.4Mtr. x 20 Mtr. to minimize the joints. No Protection Required forFully Bonded HDPE Membrane Allowing Faster Construction

The fully bonded HDPE waterproofing membrane shall have following typical properties:

Property	Typical Value	Test Method
Roll Size	2.4 Mtr x 20 Mtr	
Thickness	1.2 mm	ASTM D 3767
Tensile Strength, Film	25 Mpa	ASTM D 412 Modified
Elongation	500%	ASTM D 412 Modified
Low Temperature Flexibility	-25°C Pass	ASTM D 1970
Resistance to Hydrostatic Head	>60 M	ASTM D 5385 Modified
Crack Cycling	Pass	ASTM D 836/ASTM C 1305 Modified
Peel Adhesion to Concrete	880 N/m	ASTM D 903 Modified
Dimension Stability	<2%	ASTM D 1204
Puncture Resistance	1000 N	ASTM E 154

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The entire waterproofing treatment should be guaranteed by the principal manufacturer as a system, for ten years and the work should be executed by the manufacturer inhouseapplication arm/authorized applicator who is in the field of waterproofing for the past 10 years.

METHOD STATEMENT

1. Place the membrane HDPE film side to the substrate with the adhesive /coated side up facing towards the concrete pour. End laps should bestaggered to avoid a build-up of layers.
2. Leave the plastic release liner in position until overlap procedure is completed.
3. Accurately position succeeding sheets to overlap the previous sheet 75 mm along the marked selvedge of 50mm Ensure the underside of the succeeding sheet is clean, dry and free from contamination before attempting to overlap.
4. Peel back the plastic release liner from between the overlaps as the two layers are bonded together. Ensure a continuous bond is achieved without creases and roll firmly with a heavy roller.
5. Completely remove the plastic liner to expose the protective coating. Any initial tack will quickly disappear.

Mode of measurement: The installed plan area shall be measured for payments. The rates shall include the cost all operations as specified above, overlaps, wastages etc., all labor, tools, material, hardware equipment for working at all heights and levels.

2. RETAINING WALL WATERPROOFING SYSTEM

Providing and laying of 1.5 mm thick SBS based self-adhesive waterproofing membrane topped with hope cross laminated film with the following technical properties-Elongation of >200 % as per ASTM D882, puncture resistance of >200 N as per ASTM E154 including cleaning the surface, priming the surface with cold applied bituminous primer@4-6 sqmtr/litre, properly sealing the joints & maintaining 75 mm overlap between the membrane selvedge & 100 mm overlap on the end joints of the membrane over the slab etc.complete. The overlap joints shall be cleaned and sealed as per manufacturers specifications including sealing corners and drains etc. or as desired as per site requirement and direction of engineer in charge. The membrane shall be taken to a height of 300 mm above theground level and terminated as per manufacturer's recommendations. Providing aluminum flashing,

wherever required for termination of membrane at all locations and finally sealing the strip using Polysulphide sealant. The laid membrane shall be covered with protection board - spot bonded on retaining wall before backfilling 8mm thick HDPE dimple board with compressive not less than 200kN/m2.

The SBS based waterproofing membrane shall have following typical properties:

Product	Test Standard	Results
Top surface		Cross laminated HDPE valeron
Softening point	ASTM D 36	>105
Tensile Strength (L/T), (N/mm2) Film	ASTM D 882	L 34 - 50, T 40-56
Elongation (L/T), (%) Film	ASTM D 882	L 200-260 , T 160-200
Tear Resistance (L/T), (N) Film	ASTM D 1004	L 240 - 440, T 220-400
Puncture Resistance, (N)	ASTM E 154	> 200
Hydrostatic pressure	BS EN 12390 (Part 8)	> 50 m (5BAR) No leakage
Crack Bridging Ability, (mm)		> 1.5

The entire waterproofing treatment should be guaranteed by the principal manufacturer as a system, it shall carry a guarantee for a period of 10 years which shall be passed onback to back in the name of the Client.

Method Statement:

- The substrate must be free of all dirt, oil grease and loosely adhering particles and made dry. Any dew settled or concrete dampness should be thoroughly cleaned using a dry cloth.Honeycomb and spalled concrete areto be repaired and all nail heads and protrusions that are likely to puncture the membranes must be removed. Any new concrete should be cured for a minimum period of 7 days before any water proofing membrane can be laid.
- All concrete surfaces will then be primed with a solvent based Bitumen Primer.
- Unroll only the required length of the membrane and cut thepieces to thedesired length and shape.
- Place the membrane pieces on the area to be covered and check whetherthe pieces match with the profile of the markedsubstrate.
- Re-roll the membrane for about half the length without changing its orientation. Then slowly unroll the membrane, peel off the release film and carefully place the membrane on the surface.

- Smoothen out any entrapped air by pressing from the centre to the sides.
- The subsequent rolls are to be laid in such a fashion that there is a75 mm side overlap on sides and 100mm end overlap.
- The applied membrane is then to be protected from damage by installing 8 mm thick HDPE dimple board spot bonded on retaining wall before backfilling.

Aluminium Flashing

Aluminum flashing, wherever required for termination of self-adhesive membrane at all locations. Item shall include rates for membrane termination on the Vertical retaining wall at height as specified in drawings for termination of the membrane and finally sealing the strip using Polysulphide sealant as recommended by manufacturer and approved by Engineer-in-charge.

Mode of measurement: The installed plan area shall be measured for payments. The rates shall include the cost all operations as specified above, overlaps, termination above ground level, wastages etc., all labour, tools, material, hardware equipment for working at all heights and levels. HDPE dimple board shall be paid separately under relevant item of the bill of quantities. Aluminum flashing shall be measured in running meter length ofinstallation.

3. DIMPLE BOARD

Providing & Fixing of protection board 8MM – HDPE Dimple board on retaining wall before backfilling all complete as per drawings and as directedby the Engineer-in-charge

The properties shall be as follows

Colour	Black	Roll Dimension	2 m x 20 m
Weight per M^2	500 grm	M^2 / roll	40
Sheet Thickness	500 microns	Roll weight (kg)	20
Dimple height	8 mm	Compressive Strength	Up to 21,000 kg/M^2

Installation

a) Preparatory work: Excavation should be completed prior to the installation.
b) Alignment: Unroll and align the dimple board
c) The surface of RCC shall be thoroughly cleaned and free fromoil, dirt, dust, grease and other impurities.
d) The surface shall be inspected and approved by Engineer-in- charge before commencement of installation.
e) Overlaps should be minimum of 4 inches (100 mm) wide.
f) Primer coat for watertight overlaps may be used as recommended by the manufacturer and approve by Engineer-in-charge

Mode of measurement: The installed plan area shall be measured for payments. The rates shall include the cost all operations as specified above, overlaps, termination above ground level, wastages, primer etc., all labor, tools, material, hardware equipment for working at all heights and levels.

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4. TERRACES / ROOF SLABS

The water proofing shall comprise of the following

a) Repairing cracks by cutting and making V-groove in 25x25 mm, withpolymer modified mortar using SBR latex, filling the groove with CM(1:3) mixed with approved polymer 10% by weight of cement

b) Spray apply an average 50mm thick PU foam insulation with a coredensity as per ASTM D1622 of 45-50 kg/m3 , thermal conductivity of 0.023 W/m.k at 25 degree mean temperature as per ASTM C518/91,compressive strength with rise of 4.2 kg/cm2 as per ASTM D-1621/94,Tensile strength 5.1 Kg/cm2 as per ASTM D1623/78,Closed cell content, apparent vol,% of 96-98, fireresistance property confirming to class B2 as per DIN 4102.

c) Applying liquid-applied, highly permanent elastic, cold applied and cold curing, one component, based on pure elastomeric hydrophobicpolyurethane resins, Solvent based with root resistance properties polyurethane membrane with elongation of 400% as per ASTM D 412,tensile strength of 4 Nsqmm as per ASTM D412,shore hardness(shore A scale) 65 as per ASTM D 2240,adhesion toconcrete > 2.0 N/mm2 as per ASTM D 903 applied in 2 coats at a total consumption of min. 1.8 Kg./ Sq. Mt. to achieve a DFT of 1.2 mm.

d) The entire waterproofing treatment should be guaranteed by the principal manufacturer as a system, for ten years and the work should be executed as per manufacturer recommendations.

e) Providing and Laying of average 75mm thick (or suitable thickness for necessary slope) fibrated concrete screed of M 20 grade with Glass / Polypropylene fibres shall be cast into these bays, from an RMC pump.

f) Providing and applying one coat of water based acrylic emulsion primer (diluted with water in the ratio of 2:1) and applied by roller / brush @ 9 to 10 Sq. Mt. per Litre and thereafter providing and applying two coats of fibre reinforced acrylic coating, having elongation of 100% as per ASTM D412:2000, crack bridging capacityof 1 mm as per ASTM D 836 ,Tensile Strength of 1 N/mm2 as per ASTM D 412 :2000 with SRI Index of 99% to be applied by roller / brush with a total consumption of approx. 1.1 to 1.2 Sq. Mt. per Litre to create a total DFT of minimum 500 micron all as per manufacturer's Recommendation etc. complete.

Mode of measurement: The installed plan area shall be measured for payments. The rates shall include the cost all operations as specified above,overlaps, vertical termination, wastages, etc., all labor, tools, material,hardware equipment for working at all heights and levels.

5. WATERPROOFING OF UGT/ OHT WATERTANKS

1.0 Water Tank

Providing and applying two component polymer based cementitious waterproofing system comprising of the following;

1. Cleaning the internal surface areas thoroughly so that they are free of all contaminants like dirt and laitance & to remove all the loose materials by various mechanical means. Removal of all surface imperfections, protrusions, loose concrete & filling of cracks using

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approved Polymer Modified Mortar in the ratio Cement: Sand (1:4) and 5% by weight of cement.

2. Providing & grouting at construction joints with approved cementitious grout into each nozzle (1 mtr c/c) at regular intervals asper the requirements.
3. Providing and making fillets at the junction of the walls and the slabsusing cement mortar of 1:4 mix admixed with 5 % of SBR latex by weight ofcement.
4. Applying 3 coats of 2 component, pre-packed, polymer modified cementitious coating of tensile strength of 5.0 N/Sq.mm as per ASTMD 412,elongation of 120% as per ASTM D 412 ,crack bridging of 2mm as per ASTM C836,applied@ 3kg/sq.mtr all over the slab including the angular fillets and extendable over the vertical walls .
5. Finally sprinkling sand over the third coat for better adhesion with plaster. The interval between each coat of coating application is 6-8hrs.
6. The entire waterproofing treatment should be guaranteed by the principal manufacturer as a system, for ten years and the work should be executed as per manufacturer recommendations.
7. Providing & laying a protection layer of 25 mm thick cement mortar admixed with integral waterproofing compound as per IS 2645

Mode of measurement: The applied plan area shall be measured for payments. The rates shall include the cost all operations as specified above,overlaps, vertical termination, wastages, etc., all labor, tools, material,hardware equipment for working at all heights and levels.

2.0 STP Tank

Providing and applying two component polymer based cementitious waterproofing system comprising of the following;

1. Cleaning the internal surface areas thoroughly so that they are freeof all contaminants like dirt and laitance & to remove all the loose materials by various mechanical means.
2. Providing & applying 2 coats of Coal Tar Epoxy at a consumption of3 sq.mtr/Kg with Bonding / adhesion of 1.2 to 1.4 N/mm2 as per ASTM D 4541,
3. Water resistance, immersion – 7 days passes as per ASTM D 870- 09, Chemical resistance, immersion in dilute acid alkali & salt solutions – 7 days -Passes as per ASTM 868.
4. Providing & laying a protection layer of 25 mm thick cement mortar admixed with integral waterproofing compound as per IS 2645
5. The entire waterproofing treatment should be guaranteed by the principal manufacturer as a system, for ten years and the work should be executed as per manufacturer recommendations.

Mode of measurement: The applied plan area shall be measured for payments. The rates shall include the cost all operations as specified above,overlaps, vertical termination, wastages, 25mm thick cement mortar etc., alllabor, tools, material, hardware equipment for working at all heights and levels.

SECTION-F

WALL FINISHES WORK

1.0 Concrete Panel 2D

Providing and fixing of Concrete Panel Cladding of dimension 1200 x 800 x 20 mm or size as per Architect with modules of 1205 x 805 mm c/c, varying in grooves of 4-6 mm with wind resistance topositive/negative pressure 2.0 kn/m². (with 1.5 FOS).

The system shall be structurally supported by Aluminum vertical tube of size as per structural calculation. The vertical Aluminum tubes willbe fixed with Hot Dip Galvanized (HDG) steel brackets of various sizes as per site condition/s and as per structural calculation.

SS-Nut bolt of approx. size 10 x 80 mm will be used to fix HDG brackets with Aluminum vertical tubes. The HDG steel brackets to befixed on the existing civil structure (in masonry work and RCC) with SS fasteners by Hilti or equivalent.

From the front side of panels, SS Self drilling screws of approx. size6.3x100mm with approx. outer dia of 10 mm SS cylinder will be usedto fix the panel on the Aluminum vertical members along with the EPDM rubber (40 x 40 x 5/10 mm approx.) sleeved over the self- drilling screws to cover the gap between (avg. 10mm) the MS verticalmembers and the back face of panel or as per site condition.

For 1200 x 800 x 20 mm panel, the standard edge distance of a self-drilling screw will be 150 mm, horizontally and vertically both sides. Cut size panels will be used at corners, ends, middle, junction etc. of walls at site as per approved shop drawings / actual site condition. Minimum 2 self-drilling screws will be used to fix the cut panels. Cutpanels of size more than 400mm in length and height will be fixed by4 self-drilling screws.

After fixing the panels, self-drilling screw's head will be covered withSS Caps (dia approx. 30mm) to give the desired look at the time of finishing / handing over.

The Panel has to have tolerances in length (± 0.2%), width (± 0.2%),thickness (± 7%), orthogonality (±1%), straightness of edges (± 0.05%), surface flatness (±1%), absorption (≤ 0.5%), freeze/thaw resistance (resistant XF4), fire protection (fire resistant A1), bending strength (8.2 Mpa N/mmsq), compressive strength (C50/60), abrasion resistance (XK1), thermal expansion coefficient (10 x 10- 6K- 1).

Contractor shall take prior approval on shop drawing from Engineer-in-charge before commencement of works on site.

Mode of Measurement: - The measurement shall be based on square meter area of installation of Concrete panel. The rate shall include erecting and removing scaffolding equipment, panels, framework, brackets, screws, all hardware including clamps etc. and all operations as specified above all complete as per drawings and as directed by the Engineer.

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2.0 Concrete Panel 3D

Providing and fixing of concrete 3d tiles of Dimensions 200 x 173 x 25 mm (variablethickness) Sleek finish with wind resistance to positive/negative pressure of 2kn/sqmt (with 1.5 FOS), and weight of approx. 44 kg/m².

The concrete 3d tiles of Dimensions 200 x 173 x 25 mm (variable thickness) to be fixed on wall with cement sand mortar mix ratio 1:6 (1 cement : 6 sand) up to 25mm thick as wet cladding (on civil structure), joints to be cleaned and grouted with matching Colour approved qualitypolymer based readymade grout of approved make.

The tiles shall be laid and fixed with pattern, style and orientation as perdrawings and as directed by the Engineer-in-charge.

The concrete 3d tiles has to have tolerances in length (± 0.5%), width (±0.5%), thickness (±7%), orthogonality (±1%), straightness of edges (± 0.05%), surface flatness (±1%), absorption (≤ 0.5%), freeze/thaw resistance (resistant XF4), fire protection (fire resistant A1), bending strength (8.2 Mpa N/mmsq), compressive strength (C50/60), abrasion resistance (XK1) and thermal expansion coefficient (10 x 10-6K-1). Contractor shall take prior approval on shop drawing before commencement of work.

Mode of Measurement: - The measurement shall be based on square meter area of installation of Concrete Panel. The rate shall include erecting and removing scaffolding equipment, joints, stone wastages, cement mortar, all hardware excluding clamps etc. inkling all operationsas listed above all complete as per drawings and as directed by the Engineer.

3.0 Wooden Perforated Wall Panelling

(i) **Medium Density Particle Board** – shall comply with IS 3087: 2005 (orlatest version).

a) Density shall be 700-720 kg per cum

b) The board shall not crack, split or chip when drilled, sawed or nailed perpendicular to the plane of the board. The surfaces of the board shall be free from stains, cracks, blisters and deformations.

c) The dimensions (length, width and thickness) shall be measuredaccording to the procedure given in IS 3087: 2005. The squareness and edge straightness of the boards when measured according to the procedure given in IS 3087: 2005. The properties shall be as follows
Length: +/- 3mm Width:
+/- 3mm Thickness:
+/- 0.4mm
Moisture content: 5% - 15% (Min - Max)
Swelling in thickness, percent, Max 24h immersion in water: 6% Tensile strength perpendicular to the plane of the board: 0.45 N/mm² Modulus of rupture: Average15 N/mm²
Modulus of elasticity: Average 2500 N/mm²

d) Thickness shall be as per approval of the Engineer and asindicated in the drawings.

(ii) Workmanship

The medium density particle wall panels in sizes 2440 x 128 mm and 15- 16mm of thickness as indicated in the drawings shall be fixed over the aluminum splices with using of clips and Filled with Sound Absorbing non- woven acoustical fleece of 0.27mm thick with a surface density of 63 g/sqmas per manufacturers recommendations or approved by the Engineer-in- charge. The boards shall have a special perforation pattern. The edges of panels shall be tongue and grooved to receive special clips for installation by the directions of Engineer. The entire system shall be fixed as indicated in the drawings or as per directed by the Engineer.

Mode of measurement: - The payment shall be made based on theinstalled area and shall include the cost of all operations as specified above.The quoted rates shall include cost of all material, labor, workmanship, tools,plants, scaffolding, hardware etc. for working at all heights and levels. The rates shall also include the cost of making openings / cutouts for Electrical fixtures, HVAC etc. as per drawings and as directed by the Engineer-in- charge.

4.0 Acoustic fabric wall panelling –

Providing and fixing glass-wool acoustic wall paneling of approved makein thickness 40 mm having noise reduction co-efficient of 0.70 - 0.80 andhumidity resistance of 95%.

The exposed surface and strengthened all edges are covered with resistant fabric of approved Colour.

The back of the tile to be covered with glass tissue.

The unique edge design folding proceeds 3-5cm on the back surface. The core material is made with 95 kg/m3 high density glass wool. Thewall panel meet stringent international fire standards like class B s2 d0according to UNE-EN 13501- 1:2007.

Mode of measurement: - The payment shall be made based on theinstalled area and shall include the cost of all operations as specified above.The quoted rates shall include cost of all material, labor, workmanship, tools,plants, scaffolding, hardware etc. for working at all heights and levels. The rates shall also include the cost of making openings / cutouts for Electrical fixtures, HVAC etc. as per drawings and as directed by the Engineer.

5.0 Acrylic solid surface 6mm thick: -

1. The works shall comprise of providing and fixing 6mm thick Acrylic solid surface in approved colour and shade in wall cladding over Brick/ RCC Walls over approved 10/12mm thick cement particle board fixed to aluminium sections. Acrylic solid surface should be Antibacterial, anti-fungal, BWR heat resistant,insulative & stain resistant
2. Physical properties of acrylic solid surface shall be as describedin this document

Cement particle board-

Distinct particle or fraction of wood or other lignocellulosic material produced mechanically for use as the aggregate for a particle board. This may be in the form of flake, granule, shaving splinter and sliver. Cement particle board comprises of the following

a. The minimum density of Cement particle board should be 1250 kg per cum
b. Moisture content not more than 12 percent of total weight
c. The maximum water absorption not more than 13 percent of total weight in 2hours and 24

percent in 24hours

d. Modules of rapture under following conditions

   a. dry condition – 9N/mm2 (minimum)

   b. wet conditions – 5.5N/mm2 (Specimens are soaked in waterat 27 +/- 2°C for a period of 24 h)

Workmanship

The acrylic solid surface 6mm thick in sizes as indicated in the drawings shall be pasted over 10/12mm thick Cement particle boardusing approved adhesive as above. The entire system shall be fixedover aluminum tubular section 1.5mm thick anchored to Wall/RCC surface with fasteners in panel of size 600 x 600mm in line and levelor as approved by the Engineer

Mode of measurement:- The installed area shall be considered for paymentand shall include all operations as listed above including cement particle board, Acrylic Solid surface, Aluminum sections, Adhesive, sealant, cutting in contours and rounding's as indicated in drawings with rounding of edges,buffing, polishing, cutouts as indicated in drawings, all joint adhesives, acrylic silicon sealants, wastages, mockup / samples as desired by the Engineer, preparation of templates including all tools, plants, hardware, scaffolding, supporting systems, machinery etc. at all heights and levels. Thesolid surface should carry a guarantee for a period of 5 years which shall bepassed on back to back in the name of the Client.

6. Terracotta Façade Cladding

The works shall comprise of Design, Supply and fixing of Extruded Hollow Terracotta Ventilated Rainscreen Facade Tiles with UnitizedCladding System. The work shall be followed as per the Drawings oras per the Engineer.

1. Terracotta Façade tiles Should have a maximum of 12% water absorption.
2. The aluminium unitized panel frame and tile system shall be designed to withstand a design minimum wind pressure of 275 kg/sq.m (including all factors of safety) in line with design drawing intent, fabricated, fixed at all levels, elevation and heights to the concrete beams and/ or columns.
3. The tile cladding sub-framework shall consist of horizontal aluminium 'C'-clamps measuring 56x35x75mm length for holding the tiles
4. screwed to the outer faces of the vertical aluminium sections at maximum 250mm c/c using two self-tapping / self-drilling AISI 304 stainless steel screws of dimensions 5.5 x 25mm
5. Special EPDM profiles of 100mm length shall be inserted in the slotsprovided in the aluminium 'C' clamps and thereafter the tiles shall beinserted and mounted on the 'C' clamps, with the EPDM profiles behind, such that the tiles are supported at top and bottom at both ends.
6. The unitized panels fitted with the tiles shall be fixed to the RCC beams and / or columns.

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with necessary HDG (minimum 80 microns)Steel brackets and anchor fasteners, based on a structural / static calculation.

7. The extruded aluminium sections shall be in alloy 6063 T5/T6 temperand natural anodized (25 microns).
8. Contractor shall take prior approval on shop drawing with all design calculations before commencement of work.

Mode of measurement:- The Installed area shall be measured to Considered for payment and shall include all operations as listed above including as indicated in drawings and preparation of templates including all tools, plants, hardware, supporting systems, machinery, fasteners, aluminum frame work, EPDM profiles, clamps etc. at all heights and levels all complete as per drawing and as directed by the engineer.

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SECTION – G MISCELLANEOUS WORKS

1.0 Toilet Cubical

Providing and fixing Toilet cubical with the followingspecifications Thickness of Compact Laminate: 18 mm
Color of HPL Boards: As approved by Engineer-in-charge Size of Cubicle: 1000mm (W) & 1550mm (D) x 2100mm (H) Door Size:
1995mm (H) x 610mm (W)
Divider Size: 1995mm (H)
Overall Height of Cubicle: 2100mm (Including boom Gap of 100mm) Accessories: Standard - Merino Make Stainless Steel -304 Grade accessories)

a) SS "U" Channel
b) SS "F" channel
c) SS Coat Hook
d) SS Privacy Thumb turn c/w Occupancy Indicator
e) SS Doorknob
f) SS Hinges with Cover
g) SS Shoe Box Leg 18mm - 316 Grade
h) Rubber Lining for Groove
i) S.S.Screws 304 G & P .V.C Wall Plugs

Mode of measurement: - The toilet cubical shall be measured in numbersof installed units including all items of work as listed above, as indicated in drawings and as directed by the Engineer all complete including tools, plants, hardware etc. at all heights and levels.

2.0 Soft board / pinup board

(A) Material
  (i) Soft board
  (ii) Commercial ply
  (iii) Wooden frame
  (iv) Laminate

Soft Board-

1. Density should be 110-120 kg per cum
2. Humidity should not greater than 8%
3. Tolerance: -
   i. Length - +/- 5mm
   ii. Thickness - +/- 2mm
4. Soft board should be 100% recyclable
5. 50mm Sound absorption - 40% at 400Hz/50Hz to 3500%
6. Sound speed on cork - 500 m/second
7. Sound absorption coefficient - 500 CPS 0.33/0.35
8. Thermal conductivity - 0.036/0.038 W/mk
9. Approved Fabric of approved thickness shall be provided overthe soft board as specified and directed by the engineer-in- charge.

10. Soft board shall be filled with foam backing of 3mm thicknessas specified and directed by the engineer.

Commercial ply-

The material specifications are as follows

b. Density 700-800 kg per cum
c. Moisture content 8-15%
d. Water resistance – Moisture Resistant
e. Nail holding strength –75 Kgs\
f. Screw Holding Strength – 225 Kgs
g. Commercial Ply board Shall followed IS: 303
h. Guarantee – 5 years against borer and termite
i. Tolerance
j. Length - +/-6mm
k. Width - +/- 3mm
l. Thickness - +/-5%
m. Water Absorption - <8%Wooden frame-

Timber used for joinery shall be of good approved quality or 2nd Class Teakwood unless otherwise specified (Ref.IS:4021) and shall be well seasoned (IS:1141) cut square, free from excess wane, from sapwood dead knot or other (Ref.IS:3364).

All timber for carpentry, joinery, rough framework, backings, grounds, fixingstrips and the like shall be treated with an approved wood preservative (Ref.IS:401) and the Contractor shall strictly observe the manufacturer's instructions for using this material. The maximum permissible moisture content in timber shall be in accordance with IS:287- latest.

All workmanship shall be of the best quality (IS:6534) Scantlings andboarding shall be accurately sawn and shall be of uniform width andthickness throughout. All carpenter's work shall be left with a sawn surface except where otherwise specified. Work shall be framed together and securely fixed in the best possible manner and with properly made joints. Allbrads, nails, screws, plugs, pins, etc. to be provided as necessary and as directed and approved.

Timber of approved quality is to be purchased at the commencement of thecontract for further seasoning on the site. The preparation of timber is to commence simultaneously with the beginning of the work generally and to proceed continuously until all the woodwork is prepared and stacked on or near the site. All the timber of large scantlings is to be sawn immediately on arrival at site to allow for any shrinkage that may take place. All timber brought to site shall be given anti-termite treatment.

Joints in various members forming any timber frame shall be provided onlyas shown in the drawings or as directed by the Engineer. Two millimeters will be allowed for each wrought face of the sizes specified except when described as finished in which case they shall hold to the full dimensions specified.

All work is to be properly tenoned, shouldered, wedged, pinned, braded, etc.to the satisfaction of the Engineer and all properly glued with best quality glue.

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All joinery shall be finished off in a proper manner, planed and sand paperedas required (IS:2338).

Use of nails shall not be permitted. All Teak Wood scantlings shall be fixedto the wall surface with wood screws of suitable size & raw plug to get in effective hold of at least 40 mm. Suitable teak wood plugs shall be providedto conceal the screw heads. All parts of woodwork resting on or set in masonry or concrete shall be well painted with two coats of bituminous paintas directed by the Engineer, prior to installations. All nails, screws, hold fasts, plates, plugs, pins required for woodwork joinery and fixing work, shallbe provided by the contractor, at his own cost. All materials shall beapproved by Engineer before using in works.

All exposed faces of woodwork shall be sand papered once before erectionfor approval of the Engineer. No Colour or other preservatives shall be applied without prior approval of the Engineer.

If after fixing in position, any shrinking or substandard materials or bad workmanship is detected, the contractor shall, forthwith remove them and replace the same at his own cost, all as directed by the Engineer.

The sizes of framework for wall and ceiling shall be governed by drawings and based on final finished proposed over the framework as directed by theEngineers.

Laminate -

Properties	**Specified as per IS:2046-1995**
Thickness	1.0 mm (±10%)
Resistance to immersion in boiling water Mass increase (%) Thickness increase (%)	10.0 % (Max) 11.8 % (Max)
Dimensional stability at deviated Temperature Longitudinal (%) Traverse (%)	0.55% (Max) 1.025% (Max)
Resistance to cracking	Should pass test
Resistance to scratching	2 N (Min)
Resistance to cigarette burns	Should pass test
Resistance to steam	Should pass test

Mode of measurement: - The Soft board/Pin Board shall be measured in numbers of installed units including all items of work as listed above, as indicated in drawings and as directed by the Engineer all complete includingtools, plants, hardware etc. at all heights and levels.

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3.0 Blinds

Providing and Fixing HONEYCOMB SHADES Manual Easy riseoperating system and standard design option.

a. The HEADRAIL shall measure 49.68 wide and 36.66mm deep & thick 1.27mm extruded from 6063 T6 aluminium alloy & shall be powder coated to a smooth finish with a thickness of 40 microns. Allcords & cord holes shall be fully concealed inside the fabric structure.As each of the hexagonal cells is formed individually, pleats operateindependent of each other providing superior pleat retention & structure strength.
b. INSTALLATION BRACKETS shall be of high-tension spring steel suitable for overhead & wall mounting 30mm DuetteHartford mounting bracket.
c. POLYESTER CORD shall be 0.9mm in diameter & of woven hollow core.
d. ENDCAP shall be moulded acrylic colour matched to the head & bottom rails.
e. BOTTOM RAIL shall be a single channel section, measuring 30mmwide and 12.5mm deep & thickness 1-1.2mm extruded from 5005 H-16 aluminium. Alloy & shall be powder coated with a smooth finish to a thickness of 15-25 microns.
f. HOLD-DOWN BRACKET (optional) shall be moulded in clear acrylic.

   It incorporates a pin for engagement with the bottom rail end-cap. Itshall be suitable for sill, face or side facing.
g. CORD.EQUILISER shall be injection moulded from impact modifiedacrylic with a high flexural modulus.

Mode of measurement: - Installed area shall be considered formeasurements. The quoted rates shall include all operations as listed at alllevels including all tools, hardware, scaffolding etc. all complete as per drawings and as directed by Engineer.

4.0 Acrylic solid surface: -

The works shall comprise of providing and fixing 12mm thick Acrylic solid surface in approved Colour and shade over Polished Kota stone with PU Sealant as per approved by Engineer. Acrylic solid surface should be Antibacterial, anti-fungal, BWR heat resistant, insulative & stain resistant

Physical properties shall be as follows

1. Tensile Strength: [6000-6800 psi]; ASTM D 638.
2. Tensile Modulus: [1.4 -1.5 x 10^6 psi]; ASTM D 638.
3. Tensile Elongation: 0.4 % minimum; ASTM D 638.
4. Flexural Strength: [10,000 - 10,400 psi]; ASTM D 790.
5. Flexural Modulus: [1.13 – 1.2 x 10^6 psi]; ASTM D 790.
6. Thermal Expansion Coefficient: 1.37 – 1.8 x 10^{-5} in./in. ^{of}; ASTM D 696.
7. Hardness (Barcol Impressor): 56 - 60; ASTM D 2583.
8. Impact Resistance: [69 in.] drop with no fracture;NEMA LD- 3, Method 3.8.
9. Izod Impact: 0.28 (ft-lb.)/in.; ASTM D 256, Method A
10. Light Resistance - Xenon: No effect; NEMA LD-3, Method 3.3.

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11.	Stain Resistance:	Pass; ANSI Z 124.3, modified.
12.	Wear and Cleanability:	Pass; ANSI Z 124.3.
13.	Fungi Resistance:	Pass; ASTM G 21.
14.	Bacterial Resistance:	Pass; ASTM G 22.
15.	Boiling Water Resistance:	No effect; NEMA LD-3, Method 3.5.
16.	High Temperature Resistance:	No effect; NEMA LD-3, Method 3.6.
17.	Weatherability:	Delta E less than 5; ASTM G 155.
18.	Moisture Absorption:	Less than 0.25 percent;ASTM D 570, long term.
19.	Specific Gravity:	[minimum 1.7 gram/cm3]; ASTM D 792.
20.	Surface Burning Characteristics:	Class I and Class A; ASTM E 84.

Joint Adhesive: Methacrylate-based adhesive for chemically bonding solid surfacing seams. Color complementary to solid surfacing sheet material. The joint adhesive shall be used of the same manufacturer as the Acrylic solid surface.

Siliconized Acrylic Sealant: Siliconized acrylic latex sealant. For general applications to fill gaps between Acrylic solid surface sheet and at terminating substrates. The sealant shall be used as per manufacturers recommendations.

Execution

1. Substrates must be sound, flat, smooth, and free from dust or other surface Contaminants.
2. Commencement of work will constitute acceptance ofsubstrates and conditions to receive the work.
3. Provide product in the largest pieces available.
4. Install solid surfacing components plumb, level, and trueaccording to approved shop drawings and manufacturer's published installation instructions. Use woodworking and specialized fabrication tools acceptable tomanufacturer.
5. Fix the Kota stone over the vanity/ Counter and make an ovalshape hole of size 662 x 567 x 160 mm as per the approveddrawings
6. Cut and finish component edges with clean, sharp returns.
7. Rout radii and contours to template.
8. Form joint seams with specified seam adhesive. Seams to beinconspicuous in completed work. Seams in locations shown on approved shop drawings and acceptable to manufacturer. Promptly remove excess adhesive.
9. Anchor securely to base cabinets or other supports
10. Fill gaps between countertop and terminating substrates with specified silicone sealant.
11. Rout cut-outs to manufacturer's template.
12. Carefully dress joints smooth, remove surface scratches and clean entire surface.
13. The entire surface shall be buffed and polished as per manufacturers recommendations to provide a smooth and cleansurface with minimum joint marks and free from scratches as directed by the Engineer.

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Mode of measurement:- The installed area shall be considered for payment and shall include all operations as listed above including PolishedKota Stone, make a required hole, cutting in contours and rounding's as indicated in drawings with rounding of edges, buffing, polishing, cutouts as indicated in drawings, all joint adhesives, acrylic silicon sealants, wastages,mockup / samples as desired by the Engineer, preparation of templates including all tools, plants, hardware, scaffolding, supporting systems etc. atall heights and levels. The solid surface should carry a guarantee for a periodof 5 years which shall be passed on back to back in the name of the Client.

5. Acrylic solid surface: -

The works shall comprise of providing and fixing 6mm thick Acrylic solid surface in approved Colour and shade fixed over 12mm thick BWP Marine ply using manufacturers approved adhesive. Acrylic solid surface should beAntibacterial, anti-fungal, BWR heat resistant, insulative & stain resistant

Physical properties shall be as follows

1.	Tensile Strength:	[6000-6800 psi]; ASTM D 638.
2.	Tensile Modulus:	[1.4 -1.5 x 10^6 psi]; ASTM D 638.
3.	Tensile Elongation:	0.4 % minimum; ASTM D 638.
4.	Flexural Strength:	[10,000 - 10,400 psi]; ASTM D 790.
5.	Flexural Modulus:	[1.13 – 1.2 x 10^6 psi]; ASTM D790.
6.	Thermal Expansion Coefficient:	1.37 – 1.8 x 10^{-5} in./in. ^oF; ASTM D 696.
7.	Hardness (Barcol Impressor):	56 - 60; ASTM D 2583.
8.	Impact Resistance:	[69 in.] drop with no fracture;NEMA LD- 3, Method 3.8.
9.	Izod Impact:	0.28 (ft-lb.)/in.; ASTM D 256, Method A.
10.	Light Resistance - Xenon:	No effect; NEMA LD-3, Method 3.3.
11.	Stain Resistance:	Pass; ANSI Z 124.3, modified.
12.	Wear and Cleanability:	Pass; ANSI Z 124.3.
13.	Fungi Resistance:	Pass; ASTM G 21.
14.	Bacterial Resistance:	Pass; ASTM G 22.
15.	Boiling Water Resistance:	No effect; NEMA LD-3, Method 3.5.
16.	High Temperature Resistance:	No effect; NEMA LD-3, Method 3.6.
17.	Weatherability:	Delta E less than 5; ASTM G 155.
18.	Moisture Absorption:	Less than 0.25 percent;ASTM D 570, long term.
19.	Specific Gravity:	[minimum 1.7 gram/cm3]; ASTM D 792.
20.	Surface Burning Characteristics:	Class I and Class A; ASTM E 84.

Joint Adhesive: Methacrylate-based adhesive for chemically bonding solidsurfacing seams. Color complementary to solid surfacing sheet material. The joint adhesive shall be used of the same manufacturer as the Acrylic solid surface. Groove between 2 sheets should be filled with solid surface adhesive with same shade and manufactured by the same manufacturer.

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Siliconized Acrylic Sealant: Siliconized acrylic latex sealant. For general applications to fill gaps between Acrylic solid surface sheet and at terminating substrates. The sealant shall be used as per manufacturers recommendations.

12mm thick BWP Marine ply

The material specifications are as follows

b. Density 650 kg per cum
c. Moisture content 8-10%
d. Bonding – BWP grade resin
e. Static bending strength – MOE: - Parallel to face grain > 6000 N/mm²;perpendicular to face grain > 4500 N/mm²
   MOR: Parallel to face grain > 50 N/mm²; perpendicular to face grain > 45 N/mm²
f. Guarantee – 7 years against borer and termite
g. Tolerance
   a. Length - +/-6mm
   b. Width - +/- 3mm
   c. Thickness - +/-5%
h. Preservative treatment: - GLP with CPP, ACC treatment

Execution

1. Substrates must be sound, flat, smooth, and free from dust or other surface Contaminants.
2. Commencement of work will constitute acceptance of substratesand conditions to receive the work.
3. Provide product in the largest pieces available.
4. Install solid surfacing components plumb, level, and trueaccording to approved shop drawings and manufacturer's published installation instructions. Use woodworking and specialized fabrication tools acceptable tomanufacturer.
5. Cut and finish component edges with clean, sharp returns.
6. Rout radii and contours to template.
7. Form joint seams with specified seam adhesive. Seams to be inconspicuous in completed work. Seams in locations shown on approved shop drawings and acceptable to manufacturer. Promptly remove excess adhesive.
8. Anchor securely to base cabinets or other supports
9. Fill gaps between countertop and terminating substrates withspecified silicone sealant.
10. Rout cut-outs to manufacturer's template.
11. Carefully dress joints smooth, remove surface scratches and clean entire surface.
12. The entire surface shall be buffed and polished as per manufacturers recommendations to provide a smooth and clean surface with minimum joint marks and free from scratches as directed by the Engineer.
13. Final finish shall be obtained as per drawing & directed by the engineer.

Mode of measurement:- The installed area shall be considered for payment and shall include all operations as listed above including BWP marine ply, cutting in contours and rounding's as indicated in drawings withrounding of edges, buffing, polishing, cutouts as indicated in drawings.

all joint adhesives, acrylic silicon sealants, wastages, mockup / samples as desired by the Engineer, preparation of templates including all tools, plants,hardware, scaffolding, supporting systems etc. at all heights and levels. The solid surface should carry a guarantee for a period of 5 years which shall bepassed on back to back in the name of the Client.

6. Dust mat - Durable Z-web construction provides excellent; -

(i) Material

a) Durable Z-web construction provides excellent support for light wheeled traffic such as carts and wheelchairs

(ii) Specifications

Material	Vinyl
Product Type	Scrapper Matting
Size	As indicated in drawings or as approved by Engineer-in-charge
Traffic Type	Extreme

(iii) Details

a) Unbacked construction scrapes, traps and hides dirt and debris,minimizing re- tracking into the building
b) Peaked edge design provides enhanced slip-resistance
c) Durable Z-web construction provides excellent support for lightwheeled traffic such as carts and wheelchairs
d) Easy to clean shake or wash off with a hose
e) Open construction allows easy cleaning
f) High-tech product coating for added protection
g) Durable vinyl construction
h) Unbacked to allow dirt to fall through
i) NFSI High Traction Certification

Entrance vinyl scraper matting designed for extreme traffic in outsideand recessed well applications. Vinyl Z construction allows dirt and moisture to fall through, minimizing re-tracking into the building.

Mode of Measurement: - The measurement shall be based on square meter area of installation of Dust mat all complete as per drawings and asdirected by the Engineer.

1. Dust mat - rigid-framed, open construction matting made of aluminium panels: -

Rigid-framed, open construction matting made of aluminum panels, in-filledwith Textile which combines highly effective soil-scraping and water- absorbing characteristics. The aluminum rails are 5mm spaced, and the wireinterlinks allow heavy soil, sand and grit to drop between the sections, preventing soil tracking while maintaining the matting's high-quality

appearance over time. The panels are joined with stainless steel, extra- resistant rope, which allows the matting to be rolled up for easy cleaning.

Mode of Measurement: - The measurement shall be based on square meter area of installation of Dust mat all complete as per drawings and as directed by the Engineer.

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SECTION – H

FIRE PROTECTION WORKS

1.0 Vermiculite paint

Generic

Type - A gypsum based; Spray applied Fire Resistive Material (SFRM) designed forthe fire protection of interior structural steel.

- Durable cementitious formulation
- Non-combustible
- Can be injected with Accelerator A-20 for fast set and increased yield (optional)
- Asbestos-free – complies with EPA and OSHA regulations.
- Mineral Wool free – no airborne fibres.
- Styrene free – no toxic decomposition gases.
- Economical – Maintains project on budget.
- Design flexibility with over 40 UL designs

Color-

Non-Uniform Tan

Finish -

Textured

Primer -

Primers are not required or recommended. If a primer is specified, or steel is primed, bond strength must meet minimum UL criteria. Pyro prime 775 WB is used as a primer/bonding agentto meet this requirement where specified. Southwest Type DK3 spatter coat must be used as a primer/bonding agent on cellular decks and roof decks per UL design requirements. Contact Carboline Technical Service for further information. Pyrolite fireproofing materials neitherpromote nor prevent corrosion. Fireproofing should not be considered part of the corrosion protection system

Film Build-

1/2" - 5/8" (12.7 - 15.9 mm) on initial pass

Limitations-

Not intended for permanent direct exposure to weather or excessive physical abuse beyond normal construction cycles. Not recommended for use as refractory cement or where operating temperatures exceed 200°F (93°C).

Substrates & Surface PreparationGeneral-

Prior to application, all substrates must be clean and free of loose scale, dirt, oil, grease, condensation, or any other substance that would impair adhesion. Fireproofing shall be applied to the underside of roof deck assemblies only after all roofing work has been completed, and allroof traffic has ceased. Also, care should be taken that all roof work is

completed and watertightbefore commencing installation of fire protection. Roof traffic shall be limited to maintenance after fire protection is applied and cured. No fireproofing shall be applied prior to completion of concrete work on steel floor decking

Painted/Primed Steel Decks-

Apply to painted/primed steel decking only if permitted by the UL design. If the painted/primeddeck is not an approved substrate, metal lath must first be secured to the deck surfaces in accordance with the UL requirements.

Painted/Primed Steel Joists-

Painted steel joists do not require adhesive, lath or fastening devices. It is acceptable to apply directly to steel joists

Painted/Primed Structural Steel-

Painted/primed structural steel is generally not approved by UL as an acceptable substrate forSFRMs unless the paint or primer was included in the fire test and/or UL listed for SFRM applications to structural steel. UL has established conditions that must be satisfied for application to primed or painted structural steel, including: minimum bond strength criteria; dimensional limitations for the structural members; use of a bonding agent or adhesive such as Pyro prime 775 WB; use of metal lath to provide a mechanical bond; or, use of mechanical breaks of metal lath strips or steel pins and disks. Refer to the UL Fire Resistance Directory- Volume 1

Performance Data

Test Method	Results
ASTM C177 Insulation K Factor	0.73 BTU in/hr. ft²-°F @ 75°F
ASTM E136 Combustibility	Passed (non-combustible)
ASTM E605 Density1	15 pcf (240 kg/m³) average
ASTM E736 Cohesion/Adhesion	515 psf (24.6 kPa)
ASTM E759 Deflection	Passed
ASTM E760 Impact	Passed
ASTM E761 Compressive Strength	6,019 psf (288 kPa)
ASTM E84 Surface Burning	Flame Spread: 10 Smoke Development: 0
ASTM E859 Air Erosion	0.00 g/ft² (0.00 g/m²)
ASTM E937 Corrosion	Passed
ASTM G21 Fungi Resistance	Passed (no growth)
Specific Heat	0.37 BTU/lb°F

Mixing & Thinning Mixer

Use a minimum 12 to 16 cubic foot heavy-duty mortar mixer capable of rotating at 40 rpm with rubber tipped blades that wipe the sides. 2. Use continuous feed mixer. Contact Carboline Technical Service for recommendation. Densities may vary when using this type of mixing equipment. Always mix with clean potable water. The mixer shall be kept clean and free of

any previously mixed materials which may causepremature setting of product. A 2-bag mix is recommended for paddle type mixers. Mix time should be approximately 2 minutes per bag at 52 rpm. Do not over mix. The material volume should not go over center bar of mixer. Use 10 ¾ ± 1 ½ gallons (40.6 ± 5.6 liters) of water per 45 lb. (20.4 kg) bag. Add water to themixer first with blades stopped. With mixer turned on, add material to the water and begin mixing.

Pot Life

2 hours at 70°F (21°C) and less at higher temperatures. Pot life ends when the material thickensand becomes unusable.

Application Equipment Guidelines

Listed below are general equipment guidelines for the application of this product. Job siteconditions may require modifications to these guidelines to achieve the desired results.

PUMP

This material can be pumped with a wide range of piston, rotor stator and squeeze pumps designed to pump cement & plaster materials including: Essick - model# FM9/FM5E (Rotor Stator/2L4) Putzmeister -model# S5EV(Rotor Stator/2L6) Hy-Flex - model# HZ-30E(Rotor Stator/2L6) Hy-Flex - model# H320E (Piston) Strong Mfg. - model# Spraymate 60 (Rotor Stator/2L6) Airtech - model# Swinger (Piston) Mayco

- model# PF30 (Dual Piston) Thomsen
- model# PTV 700 (Dual Piston)

Marvel kit must be removed from piston pumps.

Ball Valves

Ball valves should be located at the manifold and at the end of the surge hose to facilitate cleaning.

Material Hose

Use 15 to 25 feet (4.5 m to 7.6 m) of 3" (76 mm) I.D. or larger surge hose from the manifold. Follow with a 16" (406 mm) tapered fitting to a 2" (50 mm) I.D. hose to the spray area. Taper to15 to 20 feet (4.5 m to 6 m) of minimum 1-1/4" or 1" (25 mm) whip hose.

Standpipe

Use 3" (76 mm) I.D. aluminum tubing with quick external disconnections. Elbows should be 3"(76 mm) I.D. with minimum 36" (0.9 m).

Nozzle/Gun

Use a minimum 1" (25 mm) I.D. plaster type nozzle with shut off valve, swivel and air shut offvalve. Orifice Size and Shields
9/16 to 5/8" (9.5 mm - 15.9 mm) I.D. "blow-off" tips (mini shields optional)

Compressor

Compressor on pump must be capable of maintaining minimum 30 psi (206 kPa) and 9 to 11cfm at the nozzle.

Air Line

Use 5/8" (15.9 mm) I.D. hose with a minimum bursting pressure of 100 psi (689 kPa).

Application ProceduresGeneral

Thicknesses of 1/2" - 5/8" (12.7 mm - 15.9 mm) or less can be applied in one pass. When additional coats are required to reach specified thickness, apply subsequent coats after prior coat has set. If preceding coat has dried, dampen the surface with water prior to application ofadditional coats. Material can be injected with Accelerator A-20 solution to increase set time and yield. Type DK3 (Spatter Coat) shall be applied to all cellular floor units and to all roof deck systems where indicated by the UL design.

Field Tests

Test for thickness and density in accordance with the applicable building code, AWCI TechnicalManual 12A (Standard Practice for the Testing and Inspection of Field Applied Sprayed Fire- Resistive Materials, an Annotated Guide), and ASTM E605 (Standard Test Methods for Thickness and Density of Sprayed Fire Resistive Materials Applied to Structural Members).

Finishing

Normally left as a sprayed texture finish.

Application Conditions

Condition	Material	Surface	Ambient	Humidity
Minimum	40 °F (4 °C)	40 °F (4 °C	40 °F (4 °C	0%
Maximum	100 °F (38 °C)	125 °F (52 °C)	110 °F (43 °C)	95%

Air and substrate temperatures shall be maintained 24 hours before, during and 24 hours after application. Gypsum based products are susceptible to water and must be protected accordingly. Contact Carboline Fireproofing Technical Service for recommendations.

Curing Schedule

Surface Temp. & 50% Relative Humidity	Dry to Recoat
77 °F (25 °C	4 Hours

Recoat times will vary based upon ambient conditions and air movement. Material can be injected withAccelerator A-20 for fast set time and increased yield.

Cleanup & Safety

Cleanup

Pump, mixer and hoses should be cleaned with potable water. Sponges should be run throughthe hoses to remove any material remaining in the hoses. Wet overspray must be cleaned up with clean, potable water. Cured overspray material may be difficult to remove

and may requirechipping or scraping to remove.

Overspray

Adjacent surfaces shall be protected from damage and overspray. Sprayed fireproofing materialsmay be difficult to remove from surfaces and may cause damage to architectural finishes.

Ventilation

In enclosed areas, ventilation shall not be less than 4 complete air exchanges per hour until thematerial is dry.

Mode of measurement: - The surface area of installation shall be considered for payment and shall include all operations as listed above including all tools, plants, hardware, scaffolding, supporting systems etc. at all heights and levels.

2.0 Fire Sealant

a) Fire stop mortar system for floor (nonelectrical)

1. Providing Fire stop mortar system, with minimum 2 hours fire rating when tested in accordance with UL 1479 (American) standards, for horizontal openings in floors or slabs after passing service lines like Metal/Plastic Pipes, HVAC Duct with combustible/Non- Combustible insulations.
2. The mortar shall be a lightweight cementitious product and shall carry test certificate inaccordance with IEC 60068-2-57:1999-11 (Environmental Testing) as per Part 2-57: Test for Vibration-Time-history method and VERTEQII for seismic zone 4.
3. The product shall be age tested as per Dafstb and DIBT standards.
4. The product shall carry test certificate for mold resistance rating of 0 as determined byASTM G21-96.
5. The product shall be UL listed & classified and shall bear the UL approval logo on the packing.
6. Firestop installation should be done by manufacturer recommended applicators . Applicator needs to provide complete installation report through Software CFS DM forinspection purpose

Mode of measurement: - The surface area of installation shall be considered for payment and shall include all operations as listed above including all tools, plants, hardware, scaffolding, supporting systems etc. at all heights and levels.

b) Acrylic fire stop sealant for walls (nonelectrical)

1. Providing Acrylic Firestop Sealant in gaps between wall to non-combustible penetrants likeSteel pipes, HVAC duct without insultanton to provide minimum 2 hours fire rating when subjectto the test conditions of UL 2079 standards.
2. The product shall be age tested as per DafStb guidelines.
3. Sealant should provide enough MAF, water and gas tight seal.
4. Sealant shall also provide airborne sound transmission reduction (STC of 50) and shall be tested as per DIN 52210 for sound insulation.
5. Sealant shall carry test certificate for mold resistance rating of 0 as determined by ASTM G21- 96 and should have a VOC content of approx. 75 g/l as per LEED 2009.
6. The sealant shall carry test certificate in accordance with IEC 60068-2-57:1999-11 (Environmental Testing) as per Part 2-57: Test for Vibration-Time-history method and VERTEQII for seismic zone 4.

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7. The product shall be UL listed & classified and shall bear the UL and FM approval logo on the packing.

8. Firestop installation should be done by manufacturer recommended applicators

. Applicator needs to provide complete installation report through Software CFS DM for inspection purpose. Through Penetration on Wall with Noncombustible Penetrants (Steel Pipes, HVAC Duct- Without Insulations), Bus Ducts, Dampers)

Mode of measurement: - The length of installation shall be considered for payment and shall includeall operations as listed above including all tools, plants, hardware, scaffolding, supporting systems etc.at all heights and levels.

c) High performance intumescent firestop sealant for walls (nonelectrical)

1. Providing High performance intumescent firestop sealant that helps protect combustible penetrations like PVC pipes up to 2", HVAC duct with combustible insulants for up to 4 hours fire rating in according to UL 1479.

2. Surface burning characteristics according UL 723 (ASTM E84-96).

3. Flame spread index 0 and smoke development index 5.

4. The sound transmission classification for this product according ASTM E 90-99 is 56 (STC Rating).

5. It High is mould and mildew resistant and the performance is Class 0 according ASTM G-21. Movement capability approx. 5% (ISO 11600) and the average volume shrinkage is24% according ASTM C1241.

6. Meets LEED requirements for indoor environmental quality credit (4.1 and 4.2) witha VOC content of 9 g/l.

7. Product should also Seismic tested on mechanical performance, smoke and fire-ratings.

8. Firestop installation should be done by manufacturer recommended applicators

. Applicator needs to provide complete installation report through Software CFS DM for inspection purpose.

9. Through Penetration on wall with combustible Penetrants/Insulations (Plastic Pipes, HVAC Duct- With Insulations),

Mode of measurement: - The length of installation shall be considered for payment and shall includeall operations as listed above including all tools, plants, hardware, scaffolding, supporting systems etc.at all heights and levels.

a) Fire stop mortar system for floors (electrical)

1. Providing Fire stop mortar system, with minimum 2 hours fire rating when tested in accordance with UL 1479 standards, for horizontal openings in floors or slabs after passing service lines like Electrical Cables, Cable Tray, Conduits.

2. The mortar shall be a lightweight cementitious product and shall carry test certificate in accordance with IEC 60068-2-57:1999-11 (Environmental Testing) as per Part 2-57: Test for Vibration-Time-history method and VERTEQII for seismic zone 4.

3. The product shall be age tested as per Dafstb and DIBT standards.

4. The product shall carry test certificate for mold resistance rating of 0 as determined by ASTMG21-96.

5. The product shall be UL listed & classified and shall bear the UL approval logo on the packing.

6. Firestop installation should be done by manufacturer recommended applicators . Applicator needs to provide complete installation report through Software CFS DM for inspection purpose.

7. Through Penetration on Floor with combustible Penetrants like Cables with combustible sheathing, Conduits, cable trays, Bus Ducts, Electrical shaft and LV shafts.

Mode of measurement: - The surface area of installation shall be considered for payment and shall include all operations as listed above including all tools, plants, hardware, scaffolding, supporting systems etc. at all heights and levels.

b) Rodent and termite proof Fire Barriers Composite Sheet for walls

1. Supply and installation of rodent and termite proof Fire Barriers Composite Sheet up to 4 hours fire rating in accordance to UL1479 standard, shall be of approved make, ratified by FMGlobal and UL certified,

2. The Composite Sheet 3.81 mm thick, bonded with organic/inorganic fire-resistive elastomeric #SS 304 (Stainless steel) sheet with, one side it should be bonded with 26 gauge #SS 304 (Stainless steel) sheet. The other side it should be reinforced with hexagonal shaped #SS 304(Stainless steel) wire mesh and covered with aluminium foil for the penetrants and the big opening, the small gaps left around the penetrants should be closed with Intumescent sealant,or with Fire rated Mouldable Putty , which should be soft & mouldable to any shape, to give complete L Rating. Fire Barrier (Hilti Approved equivalent) with minimum 2 (two)hours fire rating when tested in accordance with ASTM E 814/UL 1479 standards,

3. This for all fire rated vertical openings in Wall made of concrete, masonry, metal, gypsum partition, after passing service lines like Cable, Cable trays, Bus Duct.

4. The products shall be UL listed & classified and shall bear the UL approval logo on the packing, FM approved products.

5. The rate shall include the all miscellaneous items etc.

6. Firestop installation should be done by manufacturer recommended applicators . Applicator needs to provide complete installation report through Software CFS DM for inspection purpose.

7. Through Penetration on Wall with combustible Penetrants ((Cables with combustible sheathing, Conduits), Bus Ducts, Cale trays Cable sealing with inducement Firestop Sealant **Mode of measurement:** - The surface area of installation shall be considered for payment and shall include all operations as listed above including all tools, plants, hardware, scaffolding, supporting systems etc. at all heights and levels.

c) Expanding fire stop foam for walls

1. Providing expanding firestop foam Hilti CP 620, with minimum 2 hours fire rating when tested in accordance with UL 1479, for horizontal openings in floors or slabs and vertical openings inwalls made of concrete/ masonry or Gypsum after passing service lines like cable trays or cables/cable bundles.

2. The expanding foam expands seven times its volume to fill the cavity at the time of dispensing the material and shall fully cure within two minutes after dispensing.

3. The product shall be age tested as per Dafstb and DIBT standards.

4. The product shall provide water tightness when tested for W rating as per UL standards andshall carry test certificate for sound insulation of 50 db. when tested in accordance with ASTME 90.

5. The product shall carry test certificate for mould resistance rating of 0 as determined by ASTM G21-96 and shall have a VOC content of approx. 1.3 g/l as per LEED 2009. The

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product shall be tested in accordance with IEC 60068-2-57:1999-11 (Environmental Testing) as per Part 2-57: Test for Vibration-Time-history method and VERTEQII for seismic zone 4.

6. The product shall be UL listed & classified and shall bear the UL and FM approval logo on the packing.

7. Firestop installation should be done by manufacturer recommended applicators

. Applicator needs to provide complete installation report through Software CFS DM for inspection purpose.

Mode of measurement: - The surface area of installation shall be considered for payment and shall include all operations as listed above including all tools, plants, hardware, scaffolding, supporting systems etc. at all heights and levels.

d) Curtain wall joint

1. Providing sprayable fire rated joint spray/ sealant to seal the gap between the horizontal slaband curtain wall to provide minimum 2 hours fire rating when tested as per ASTM E 2307 STANDARD.

2. The product to have up to +_50% Movement Capability and Sound Insulation of 55db as perASTME-90.

3. The product shall have passed the 500 cycles requirement as specified by ASTM E1399 class II.

4. The product shall carry carry test certificate for mould resistance rating of 0 as determined byASTM G21-96 and shall have a VOC content of approx. 60 g/l as per LEED 2009.

5. The product shall carry test certificate as per ASTM E 1399 class II for movement capability.

6. The product shall be UL listed & Classified and shall bear the UL and FM approval logo on the packing.

7. Product should not contain any allergic substances as carcinogenic categories.

8. Firestop installation should be done by manufacturer recommended applicators. Applicator needs to provide complete installation report through Software CFS DM for inspection purpose.Vendor needs to provide Engineering Judgement (EJ) based solution in accordance to international firestop council (IFC) and through well qualified professionals.

Mode of measurement: - The length of installation shall be considered for payment and shall includeall operations as listed above including all tools, plants, hardware, scaffolding, supporting systems etc. at all heights and levels. **Ready to use fire stop block**

1. Pre-formed, Ready to use firestop block made from intumescent polyurethane materialfor temporary or permanent firestop sealing around cables, cable bundles and conduits which are passing through concrete/Masonry/Gypsum wall in accordance to UL 1479 standards.

2. Product should also have surface burning characteristics according to UL 723 (ASTM E84-01): Flame spread index 10 and smoke development index 15.

3. The sound transmission classification for this product according ASTM E 90 is 52 (STCRating).

4. The density is 0.27 g/cm³ and the expansion temperature (intumescent activation) is around 392 °F (200°C). Seismic tested on mechanical performance, smoke and fire-ratings.

5. Product should also be tested in accordance to ASTM E 3037. Firestop installation should be done by manufacturer recommended applicators. Applicator needs to provide

completeinstallation report through Software CFS DM for inspection purpose.

Mode of measurement: - The numbers of installation shall be considered for payment and shall include all operations as listed above including all tools, plants, hardware, scaffolding, supporting systems etc. at all heights and levels.

6. **Fire/Heat Resistant Paint**

Heat resistant paint shall be applied to areas as indicated in drawings and as directed by the Engineer as per the following specifications

a. Heat Resistant of Paint should be withstanding temperature up to 700°C

b. Viscosity of Paint - 30 Sec +/- 5 Sec at 30°C

c. Primer is not required before the application of paint.

d. The Grade of paint shall be HRC-900 or approved by the engineer.

e. Three or more layers should be applied on the application area to provide Class 1.

f. Covering Capacity of paint should be 15 Sqm per Litre or as approved by Engineer-in-charge

g. Final finish of paint shall be as per Drawings or as per approved by the Engineer

h. Dry time for paint should be as following

a. Touch - 2 to 3 hours

b. Curing for Hard Dry - 200°C for 2 hour or 250°C for 1 hour

i. The Manufacturer paint should approved as per the IS 12777 and BS 476 Part 7 orapproved as per the Engineer.

Mode of measurement: - The Quantity of Paint shall be measured in liter as per the Covering Capacityof paint as specified above. Considered for payment and shall include all operations as listed above including Paint, Cleaning, Rubbing, as per indicated in drawings, preparation of templates including alltools, plants, hardware, scaffolding, supporting systems, etc. at all heights and levels.

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PLUMBING & FIRE FIGHTING WORKS

Table of Contents

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1. PLUMBING / SANITARY SYSTEMS (WATER SUPPLY & DRAINAGE)

1.1 Scope of Works - Plumbing Works for Building & Toll Plaza

Table 1.1-1 Plumbing Scope of Work for Building & Toll Plaza

Sr. No.	Description	Detailed Scope
1.	BEST HV Switching Station, Sewri	Design, procurement, supply, transportation, installation, testing & commissioning of a. Storm Water Drainage Designing / Provision shall be inaccordance with latest IS & NBC 2016 b. Storm Water Network of Appropriate Sizing along withDesirable Slopes & Invert Levels. c. Proper Termination / Connection of Storm Water Network with / into Existing Municipal / Local AuthorityStorm Water Network.
2.	A. Sub Command Centre, Sewri: B. Shivaji Nagar Command Centre C. Porta Cabins D. Main Central Command Centre Gavan	Design, procurement, supply, transportation, installation, testing & commissioning of a. Water Supply & Sewer along with Storm Water Drainage Designing / Provision shall be in accordance with latest IS & NBC 2016 b. The Principal Source of Water will be Municipal / Local Authority Water Supply. However, in case the same is not Available in Sufficient / Enough Quantity to fulfil the Project's Requirement, Alternate Source such as Tanker / Bore Well Water needs to be considered. In this event, Tanker / Bore Well Water to be Treated in accordance with Indian Standard for Potable Water Supply IS 10500. c. In case of Municipal / Local Authority / Tanker Water Supply is not Available then Water to be Drawn from Adequate No. of Bore Wells. No. to be based on Actual Water Requirement & Water Yield from Each Bore Well. d. Adequate Size of Water Supply Pipeline from Source of Water up to / till UG Tanks. e. UG Tank Capacities & its Allied Plant Room Size based on Actual Pump Capacities along with Piping, Valves etc.and Water Treatment Plant; in case Water Parameters are not within Permissible Limits as mentioned in IS:10500. f. Water Cooler along with RO of required storage capacity (minimum 40/80 Litres) as per water

			demand on each floor on each location and shall be provided as per Water quality as per IS:10500. g. Adequate Size of Water Supply Pipeline from UG Tanks up to till OH Tanks. h. OH Tank Capacities & Adequate Size of Water Supply Pipe Distribution along with Valves etc. up to / till End User. i. Adequate Size of Water Supply Pipe Distribution along with Valves etc. inside Toilets & Kitchens / Pantries. j. Adequate Size of Drainage Pipe Network inside Toilets &Kitchens / Pantries up to Adequate Size of Drainage Down take Pipes Inside Plumbing Services Shaft. k. Sewer Water Down take Pipe Termination / Connection up to / into Sewer Water Network. l. Sewer Water Network of Appropriate Sizing along with Desirable Slopes & Invert Levels. m. Proper Termination / Connection of Sewer Water Network with / into Existing Municipal / Local Authority Sewer Water Network. If Existing Municipal / Local Authority Sewer Water Network is not there, then Project's Sewer Water Network to be Terminated / Connected into Septic Tank. n. Terrace Area to have Adequate No. of Storm Water Outlets along with Down takes. Terrace Area to be Adequately Screed towards Outlets. o. Storm Water Down take Pipe Termination / Connection up to / into Storm Water Network. p. Storm Water Network of Appropriate Sizing along with Desirable Slopes & Invert Levels. q. Proper Termination / Connection of Storm Water Network with / into Existing Municipal / Local Authority Storm Water Network.
3.	A. 4 lane/ 6 lane Toll Plaza & Tunnel	Design, procurement, supply, transportation, installation, testing & commissioning of	

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	B. 16 lane Toll Plazawith Tunnel	a. Roof Area to have Adequate No. of Storm Water Outletsalong with Downtakes. Roof Area to be Adequately Screed towards Outlets. b. Storm Water Downtake Pipe Termination / Connection upto / into Storm Water Network. c. Storm Water Network of Appropriate Sizing along with Desirable Slopes & Invert Levels. d. Proper Termination / Connection of Storm Water Network with / into Existing Municipal / Local Authority Storm Water Network. e. Each Toll Booth to have Stand Alone Drinking Water Dispenser. Water Parameters should be within Permissible Limits as mentioned in IS:10500. f. In Tunnel Area Storm Water Network of Appropriate Sizing along with Desirable Slopes & Invert Levels. Plus, Adequate No. of Sumps along with Desirable No. of Sump Pump Capacities. g. Sump Pumps to be Terminated / Connected into Storm Water Network. h. Raw Water Taps Provisions for General water use at either side of the Toll Gates. i. Provision of raw water and drainage water provision for all Toilets on either side of the toll locations

1.2 Reference Standards

Codes & Design Guidelines:

National Building Code of IndiaRelevant BIS Codes	Part IX 2016
Handbook of Water Supply & DrainageUniform Plumbing Code	SP-35: 1987 2008 Edition
Of India Energy Conservation Building Code Energy Policy Act 1992	2011 Edition
Central Public Health & Environmental Organization	

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1.3 Design principles

The Plumbing Services for the Administration & Command Control Center Buildings shall beDesigned keeping in view the following:

1.3.1 Requirement of Adequate Flow and Pressure of Cold Water and Hot Water (WHEREVERAPPLICABLE) in Toilets, Kitchens / Pantries and Other Designated Areas.

1.3.2 The Water Storage Tank Capacity shall be Adequate to Ensure Availability of Water required for Each Building.

1.3.3 Implementation of requirements of MOEF relating to Rain Water Harvesting, Water Conservation, etc.

1.3.4 Levels of Roads / Pavements & Other Services in the Area.

1.3.5 Drainage & Water Supply provision for Irrigation.

1.3.6 Water Conservation using Low Flow Fixtures.

1.3.7 Energy Gonservation Measures.

1.4 System Requirements

1.4.1 The Principal Source of Water will be Municipal / Local Authority Water Supply. However, in case the same is not Available in Sufficient / Enough Quantity to fulfil the Project's Requirement, Alternate Source such as Tanker / Bore Well Water needs to be considered. In this event, Tanker / Bore Well Water to be Treated in accordance with Indian Standard for Potable Water Supply (IS:10500) for use of Domestic & Drinking Purpose only.

1.4.2 Overhead Storage Facility for Fire, Domestic and Flushing / Irrigation Water.
Sewage & Sullage Collection & Conveyance System based on NBC / Indian StandardsApplicable Guidelines wherever required.

1.4.3 Storm / Rain Water Drainage from the Top Terraces of the Buildings as well as from the Roof Area of Toll Booths shall be Terminated in / Connected to External Storm Water Network; whichshall also Catch the Storm Water from Roads & Other Open Areas. The External Storm Water Network Shall Ultimately be Terminated in / Connected to Municipal / Local Authority Storm Drain Network.

1.4.4 Sewage Water Drainage from the Buildings shall be Terminated in / Connected to External Sewage Water Network. The External Sewage Water Network Shall Ultimately be Terminated in
/ Connected to Municipal / Local Authority Sewage Drain Network.

1.5 Design Calculations

1.5.1 Water Requirement – Domestic & Flushing Water Demand shall be as per NBC 2016 Part-9

1.5.2 Water Storage and Transfer –
There will be Separate Fire Fighting (AS PER REQUIREMENT MENTIONED IN NBC 2016PART-4), Domestic as well as Flushing / Irrigation UG Tanks for Each Administration & Command Control Center Buildings. The Underground Water Tanks Capacity shall be of 100% of 1 Day's Requirement and 50% of 1 Day's Requirement shall be stored in Overhead Tanks of Individual Buildings.

Pump Flow Rate shall be decided based on 2 Hours of Water Transfer for Daily Requirement of the Each Building. Based on the same, Pipes will be Designed as per Hazen-Williams Formula to limit Friction Loss & Velocity of Flow in Pipes to Acceptable Values.

1.5.3 Water Distribution –

Water from Overhead Tanks shall be Distributed to various parts such as Toilet, Kitchen / Pantry and Other Designated Areas in the Each Building by means of Gravity Feed System.

Water Supply Piping will be Designed as per Hazen-Williams Formula based on the available Gravitational Head. Min. Pressure of 1.5 kgf/cm2 shall be provided at Every Toilet& 2 Kitchen / Pantry Connection / Fixture. Client to confirm the Residual Pressure Requirement.

Pressure Zones will be created by using Pressure Reducing Valves to Limit Pressure at Any Floor within 4.2 kgf/cm2 as per NBC 2016. Whenever Pressure Exceeds 4.2 kgf/cm2, and the Distribution System may not be able to withstand the same, Pressure Reducing Valves shall be installed for Reduction of Pressure.

1.5.4 Drainage System –

Drainage Pipe Sizing shall be based on NBC 2016; according to Number of Fixtures and Building Height.

External Drainage Network shall be Designed based on the Number of Fixture Units Connected, Available Gradient, Connection Level at External Chamber etc. Pipes shall be Sized as per Manning's Formula.

1.5.5 Storm water –

Terrace Rain Water Downtake Piping shall be sized for Gravity Flow. Rainfall Intensity of 125 mm/hr is considered based on MOEF / Local Authority Requirement.

External Storm Water Network shall be designed as per Run Off generated from Respective Catchment Areas. Pipe Sizing / Drain Channel shall be as per Manning's Formula.

1.5.6 Irrigation –

We have considered 7 lit/m2/day Water Demand for Irrigation.

1.6 Source, Storage, Type & Treatment of Water

1.6.1 Source of Water

The Daily Potable Domestic as well as Flushing / Irrigation Water Requirement for the Each Administration & Command Control Center Buildings will be met through Municipal / Local Authority Water Supply. The Water shall be directly used for Flushing / Irrigation Purpose. The Water shall be directly used for Domestic Purpose; if Quality of Water is as per specified in the Indian Standards for Potable

Water Supply (IS: 10500). However, if the Quality of Water is not found suitable for Domestic & Drinking Use after Analysis; it shall be Treated in WTP before using for Domestic & Drinking Purpose. Tanker / Bore Well Water shall be used to fill Fire / Domestic / Flushing / Irrigation Tanks in case of Short Fall of Municipal / Local Authority Water Supply.

Water shall be used in the following manner:

Municipal / Local Authority Water – For Domestic & Flushing / Irrigation Use.
Tanker / Bore Well Water – In case of Shortfall in Municipal / Local Authority Water Supply.

1.6.2 Water Storage & Tank Sizing

It is Proposed to provide 1.5 Day's Water Storage Capacity based on Ultimate Requirement. The Underground Water Tanks Capacity shall be of 100% of 1 Day's Requirement and 50% of 1 Day's Requirement shall be stored in Overhead Water Tanks of Individual Buildings.
The Main Incoming from Municipal / Local Authority Water Supply Line shall be led into Fire Reserve UG Tanks; from there it shall be allowed to Overflow in Domestic Water UG Tank. TheMain Incoming from Municipal / Local Authority Water Supply Line shall also be led into Flushing / Irrigation Water UG Tank. Proposed Water Storage Capacities are Tabulated under Annexure PHE-01.

1.6.3 Water Type & Treatment

If the Quality of Municipal / Local Authority Water is not found suitable for Domestic & Drinking Use after Analysis; then Water from Raw Domestic Water Tank shall be Treated in WTP & thenStored in Treated Domestic Water Tank. During Shortfall of Municipal / Local Authority Water; Tanker / Bore Well Water shall be Used & Stored in Raw Domestic Water Tank.

1.6.3.1 Water Coolers:

Provision of water purifier cum storage water cooler (minimum capacity 40 /80 Litres) shall be considered each floor of all locations of suitable capacity as per specification which covers the requirements of design, engineering, manufacture, inspection and testing, packing / forwarding and supply at site, supervision of erection and commissioning and providing mechanical and performance guarantees of water purifier cum storage water cooler as per the specification. The equipment shall conform in all respects to high standards of design, engineering and workmanship.

General Requirements :

a. Complete package contract shall be awarded to the contractor for installation of all Equipment, piping, fitting and Piping specials.

b. Supplier shall ensure that no damage to the other Equipment and their parts, structures while executing the work.

c. Supplier shall arrange for Safekeeping and storage of Material at site at his risk and cost, till site is handed over after completion.

d. Dimensions of the cooler should be as per RBML's sales building layout drawing to

accommodate the water cooler in designated place in all type of sales building.

e. Proper space should be available for safe operation & maintenance of cooler.

f. Supplier to provide water test certificate as per IS:10500.

Specific Requirements

The Basis of Design of Water purifier cum storage water cooler shall be as follows:

g. Type of Water Cooler: Water purifier cum storage water cooler

h. Ambient condition: 5° C to 55° C

i. Electric Supply: 240 V A.C, ± 10 % phase, Frequency 50 Hz ± 3 %

j. Dimension: As per building layout at all locations

k. Purified Water Flow Rate: 50 LPH

l. Storage Capacity: 40/80 Litres

m. Mounting: Floor

n. Filtration / Purification Modules: RO+UV & UV (Water quality as per IS:10500)

o. Location: outside Building (in closed area)

p. Area Classification: Safe & pure water as recommended by IS:10500 standard.

Sr. No.	Code Reference No.	Code Title	Specification related to code
1	NBC 2016 Part -9	National Building Code of India; Part -9 PLUMBING SERVICES	Specification on Public health Engineering
2	UPC India 2017	Uniform Plumbing Code - India	Specification on Public health Engineering
3	SP 35	Standard Practice 35	Code of Water supply & Drainage Practices in India
4	IS 10500	Drinking water standard	Code for Information on acceptable drinking water standards (Upper Limit)

1.6.4 **Water Supply & Distribution**

Supply System:

Underground Tank (UGT):

There will be Separate Fire Fighting (AS PER REQUIREMENT MENTIONED IN NBC 2016PART-4), Domestic as well as Flushing / Irrigation UG Tanks for Each Administration & Command Control Center Buildings. The Underground Water Tanks Capacity shall be of 100% of 1 Day's Water Requirement. In Addition to Domestic Water Storage, there shall beCompartment / Space for Fire & Flushing / Irrigation Water in this UG Tank Area. The Fire Tank Capacity shall be as per NBC 2016 / Fire No Objection Certificate (NOC).

Overhead Tank (OHT):

50% of 1 Day's Water Requirement shall be stored in Overhead Tanks of Individual Building.The Pumps will Operate Automatically based on Water Level in the OH Tanks.

Landscape:

Water for Irrigation shall be sourced from Flushing cum Irrigation Water Tank. The Landscape Water Supply System comprising of Pumping, Piping, Water Supply Nozzles and Control Equipment shall be Designed & Built by the Appointed Irrigation Water Supply Vendor.

Distribution System:

Water for Domestic & Flushing / Irrigation Use shall be distributed by Gravity from Overhead Tanks. Pressure Zones will be created by using Pressure Reducing Valves to Limit Pressure atAny Floor within 4.2kgf/cm2 as per NBC 2016.

1.7 Drainage System

1.7.1 Sewage & Sullage

The Soil & Waste shall be carried down separately in independent Downtake Pipes. Two Pipe Drainage Systems shall be adopted as per NBC 2016 Standards. The Sanitary / Soil, Waste & Vent System shall be Water Tight & Gas Tight Designed to prevent escape of Foul Gas & Odour from Various Fixtures.

Vent System shall be Designed to facilitate escape of Gases & Odour from all parts of Sanitary /Soil & Waste System to the Atmosphere at a point above the Building & to allow Admittance of Air to All Part of the System, so that Siphon, Aspiration or Back Pressure Conditions do not cause Loss of Seal at Traps & Entry of Foul Gases Inside Habitable Areas.

The Toilets & Kitchens / Pantries will have Sunk from 150 mm to 300 mm to Lay Drainage Pipesin Sunken Area with required Slope & the Horizontal Header shall be Subsequently Connected to the Vertical Stack Located Inside the Associated Pipe Shaft which shall be Coordinated carefully with Other Services & in Consultation with Architect / Other Stake Holder. Care shall be taken to Avoid Pipe running thru' / in Electrical Rooms and Other Critical Areas.

Provision for Cleaning & Rodding Eyes shall be made at Strategic Locations to allow the System Maintenance.

Cast Iron Pipes shall be used for Ceiling Suspended Pipe Diversions. (WHEREVER APPLICABLE)

If Existing Municipal / Local Authority Sewer Water Network is not there, then Project's SewerWater Network to be Terminated / Connected into Septic Tank.

1.8 External Drainage

The following Parameters / Site Conditions shall be kept in mind when Designing & Executingthe Sewage, Sullage and Storm Water Drainage System / Network:

- HFL of Nearest Discharge Point / Nalla.
- Peak Rainfall Intensity of 125 mm/hr.
- Natural Slope of the Area.
- Layout of Different Facility in the Building.
- Sub-Soil Water Table.
- Soil Condition.
- Provision of Sewage Lifting Station. (IF REQUIRED)
- Provision of Venting Arrangement for Manholes.
- Construction of Manholes & Laying of Pipes considering Ground Condition.
- Termination of Vent Cowl at Terrace Level.
- Provision of Adequate Slope for Horizontal Header.

1.8.1 Design Criteria for Sewage Water Drainage

The System shall be Designed as per following Design Criteria Stipulated in the "Manual for Sewerage & Treatment" Published by the Central Public Health & Environment Engineering Organization, Ministry of Urban Development, Govt. of India, IS-SP/35(S&T)-1987 and NationalPractices on the Subject.

a.	Flow of Sewage	:	Up to 85% of Domestic Water Supply(Average Daily) Up to 100% of Flushing Water Supply (Average Daily)
b.	Peak Flow	:	3 Times Average Flow
c.	Min. Diameter of Pipe	:	150 mm Dia
d.	Min. Velocity in Pipe	:	0.75 m/s
e.	Max. Velocity in Pipe	:	Less than 2.4 m/s
f.	Flow Conditions in Pipes -Pipes up to 400 mm Dia Pipes Larger than 400 mm Dia	: :	0.50 Full Running 0.67 Full Running
g.	Min. Depth of Pipe BelowGround Level - For Branches For Other	 : :	 0.6 m 1.0 m
h.	Formula for Calculation & Design of Sewer Lines	:	Manning's Formula

1.8.2 Rain & Storm Water DrainageRain Water Drainage -

Rain Water from Top Terrace for Each Administration & Command Control Center Buildings aswell as from the Roof Area of Toll Booths shall be collected by means of Vertical Pipes. The Downtake Pipe System for Rain Water shall be Conventional Gravity-based System. Rain Water Pipes shall be Terminated in / Connected to External Storm Water Network. Cast Iron Pipes shall be used for Ceiling Suspended Pipe Diversions. (WHEREVER APPLICABLE)

Storm Water Drainage -

Storm Water Drainage System for the Project shall be Designed for Rainfall

Intensity of 125 mm/hr. External Storm Water from Roads & Open Areas shall be Collected by means of Catch pits with Gratings on Top. Either Open Drain Network System or Pipe & Chamber Network System shall be used for Ultimately Connect to External Municipal / Local Authority Storm Water Chamber.

1.8.3 Design Criteria for Rain & Storm Water Drainage

The System shall be Designed as per following Design Criteria:

a.	Intensity of Rainfall	:	125 mm/hr (As per MOEF Requirement)
b.	For Hard Surface Run Off Coefficient	:	0.95 (As per MoEF Manual / Requirement)
c.	For Soft Surface Run OffCoefficient	:	0.1 to 0.5 (As per MoEF Manual / Requirement)
d.	Min. Velocity in Pipe	:	0.75 m/s
e.	Max. Velocity in Pipe	:	2.4 m/s
f.	Open Drain Starting Width	:	300 mm
g.	Open Drain Starting Depth	:	200 mm
h.	Slope	:	1:200 to 400
i.	Hydraulic Calculation	:	Manning's Formula & Rational Formula forCalculating Run Off

1.9 Hot Water Supply (WHEREVER APPLICABLE)

Hot Water in Toilets & Kitchens / Pantries shall be catered by Individual Hot Water Geysers. Separate Piping System for Hot Water is proposed to avoid Mixing of Cold Water with it.

1.10 Material of Construction of Piping

Proposed Materials for Piping. Final Call to be taken by Client.

1.10.1 Water Supply and Distribution

Sr. No.	Location and Battery Limit ofPiping	MOC of Pipes and Fittings
1	Municipal / Local Authority Connection: Municipal / Local Authority Line to Under Ground Tanks(UGT)	DI / uPVC
2	Piping within Pump Room / Tanks	GI 'C' Class
3	Rising Mains: From UGT to Over Head Tanks (OHT)	GI 'C' Class
4	Terrace Looping: From OHT to ShaftValve	GI 'C' Class
5	Downtake Pipes: From Shaft Valve toToilet & Kitchen / Pantry Entry as well as Inside Toilet & Kitchen / Pantry	

A	For Domestic, Flushing Water Supply Pipes	uPVC Sh.40 / CPVC SDR 11
B	For Hot Water Supply Pipes	CPVC SDR 11

1.10.2 Drainage

Sr. No.	Location and Battery limit of Piping	MOC of Pipes and Fittings
1	**Internal Piping: Inside Toilet / Kitchen / Pantry**	
A	Rigid Pipe: From Wash Basin / Sink to Floor Trap	uPVC Socket (4 kg)
B	Waste Pipe: From Floor Trap to VerticalWaste Water Pipe in Shaft	SWR Ring Fitting (Type-B)
C	Soil Pipe: From WC to Vertical SoilWater Pipe in Shaft	SWR Ring Fitting (Type-B)
D	Condensate Pipe: From Indoor Unit (IDU) to Vertical Waste Water Pipe in Shaft	uPVC Socket (4 kg)
E	Perforated Pipe: In Landscape	uPVC Perforated (6 kg)
2	**Downtake Piping: Inside Shaft**	
A	Waste Pipe: From Terrace (1.5 m Above) Level to First Chamber	SWR Ring Fitting (Type-B)
B	Soil Pipe: From Terrace (1.5 m Above)Level to First Chamber	SWR Ring Fitting (Type-B)
C	Vent Pipe: From Terrace (1.5 m above) Level to Lowest Floor Connection	SWR Ring Fitting (Type-A)
D	Rain Water Pipe: From Terrace to FirstChamber	SWR Socket (Type-B)
3	**Diversion Piping: Ceiling Level Diversion at Stilt / Ground Floor**	
A	Waste Water Pipe	CI as per IS 3989
B	Soil Water Pipe	CI as per IS 3989
C	Rain Water Pipe	CI as per IS 3989
4	**External Pipe: From First Chamber to External Connection**	
A	Waste Water Pipe	DWC HDPE / uPVC
B	Soil Waterpipe	DWC HDPE / uPVC
C	Storm Water Pipe	RCC NP2 Hume Pipe

1.11 Water Consumption Data / Details

Refer Annexure PHE-01

1.12 Rain Water Downtake Water Pipe Data / Details

Refer Annexure PHE-02

2 OUTLINE PLUMBING SPECIFICATIONS-BUILDING:

2.1 Internal Drainage (Soil, Waste, Vent & Rain Water Pipes)

2.1.1 Basic Piping System

Soil, waste and vent pipes in shafts, ducts and in concealed areas i.e. false ceilings etc. shall consist of cast iron pipes & fittings as called for. In general wastes and vents smaller than and upto 50 mm dia shall be of heavy class GI.

The soil pipes shall be circular with a suitable nominal diameter. Pipes shall be fixed by means of stout GI clamps in two sections, bolted together, built into the walls, wedged and neatly jointed as directed and approved by the Owner's site representative / Architect. All bends, branches, swan neck and other parts shall conform to the requirement and standards as described for the pipes. Pipes shall be rested against the walls on suitable wooden cradles. Local authority regulations applicable to the installations shall be strictly followed.

Where indicated, the soil pipes shall be continued upwards without any diminution in its diameter, without any bend or angle to the height shown in the drawings. Joints throughout shallbe made with molten lead as described under jointing of cast iron pipes. Soil pipes shall be painted as provided under 'painting'. The soil pipes shall be covered on top with cast iron terminal outlets as directed and approved. All vertical soil pipes shall be firmly fixed to the walls with properly fixed clamps and shall as far as possible be kept 50 mm clear of wall. Waste pipesand fittings shall be of cast iron or galvanized mild steel pipes. Pipes shall be fixed, jointed and painted as described in installation of soil, waste & vent pipes.

Every Vertical Waste pipe shall be terminated / discharged into a Horizontal waste pipe with proper P-Traps. The contractor will ensure that this requirement is adequately met with. Wherever floor traps are provided, it shall be ensured that at least one wash is connected to suchfloor traps to avoid drying of water seal in the trap. Ventilating pipes shall be of cast iron or galvanized mild steel pipes, conforming to the requirements laid down earlier. Anti-syphon vent pipes/relief vent pipes where called for on the drawings shall be of cast iron or galvanized mild steel pipes as specified. The pipes shall be of the diameter shown on the drawings.

All traps on branch soil and waste pipes shall also be ventilated at a point not less than 75 mm or more than 300 mm from their highest part and on the side nearest to the soil pipe or waste pipes.

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

provide the same.

All the fittings used for connections between soil, waste and ventilation pipes and branch pipes shall be made by using pipe fittings with inspection doors for cleaning. The doors shall be provided with 3 mm thick rubber insertion packing and when closed and bolted shall be air and watertight.

Where soil, waste and ventilating pipes are accommodated in shafts ducts, adequate access to cleaning eyes shall be provided.

Head (starting point) of drains and sewage / wastewater sumps (as and where applicable) having a length of greater than 4 m upto it connection to the main drain or manhole shall be provided with 80 / 100 mm vent pipe.

2.1.2 Piping Materials

Cast Iron Pipes

Cast iron pipes and fittings shall be of good and tough quality and dark grey on fracture. The pipes and fittings shall be true to shape, smooth and cylindrical, their inner and outer surface being as nearly as practicable concentric. They shall be sound and nicely cast, shall be free from cracks, taps, pinholes and other manufacturing defects.

The pipes and fittings shall conform to BIS:3989 / BIS:1729/BBIS:15905 as called for. Fittings shall be of required degree with or without access door. All access doors shall be made up with 3 mm thick insertion rubber gasket of white lead and tightly bolted to make the fittings air and water tight. The fittings shall be of the same manufacture as the pipes used for soil and waste.

All CI pipes and fittings shall bear the manufacturer's name and ISI specification to which it conforms.

All pipes and fittings shall be coated internally and externally with the same material at the factory, the fittings being preheated prior to total immersion in a bath containing a uniformly heated composition having a tar/other suitable base. The coating material shall have good adherence and shall not scale off. The coating shall be smooth and tenacious and hard enough not to flow when exposed to a temperature of 77 degree C but not so brittle at a temperature of '0' degree C as to chip off when scratched lightly with a pen knife.

All pipes and fittings before installation at site shall be tested hydrostatically to a pressure of 0.45 Kg/sq. cm without showing any sign of leakage, sweating or other defects of any kind. The pressure shall be applied internally and shall be maintained for not less than 15 minutes. All these tests shall be carried out in the presence of the representative of the Project Manager. Alternatively, a test certificate from manufacturers be obtained before dispatch of material to site.

Cast Iron Specialties

If required, cast iron specialty items such as deep seal floor traps, urinal traps, trap integral pieces with integral inlet/outlet connections, manhole cover with frame, chamber cover etc. shall be fabricated to suit individual location requirements. The contractor shall arrange the fabricationof these items from

an approved source.

Jointing With Spun Yarn & Drip Seal:

The approximate depth and Drip Seal for various diameters of CI pipes and specials shall be asfollows:

Nominal size of Pipe(mm)	Depth of Dripseal Joint(mm)
50	25
80	25
100	25
150	38

2.1.3 Pipe Joint Sealant:

Pipe joint sealant shall be used for joining various diameters of C.I. pipes and specials. This sealant replaces the standard lead caulked joints. The application is by homogenously mixing the two pack system in cold condition.

2.1.4 Application Procedure:

Clean the pipe joints thoroughly to ensure it is free from any traces of oil, dirt or any other foreign body. Mix two parts of Drip Seal thoroughly with an iron flat to get a homogenous compound. * Place Spun yarn in the pipe joint as a filler and then take the required quantity of the compound and push it in the joint with a caulking tool, MS flat / damp finger uniformly all over to obtain a smooth and uniform joint. Dip the fingers in water every often to ensure the compound does not stick to the hands of the workmen, but this will ensure perfect sealing and the smooth surface forthe joint cement. (* The compound prepared from the two mixtures is to be used within 30 minutes) Precaution to be taken to wash hands thoroughly with soap before and after use. Preferably use disposable gloves for hand application.

Following varieties of Cast Iron Pipes are available and shall be used as specified in the Schedule of Quantities:

2.1.5 Vertically Cast or Pit Cast Pipes

Vertical Cast Pipes shall conform to IS 1537. These Pipes are not recommended for pressure applications and shall be suitable only for small projects and for temporary works.

The process of manufacturing these pipes is by casting the metal into vertical moulds which is the usual foundry method of casting in fixed sand moulds. These are called vertically cast or pit cast pipes. Spun iron pipes are more compact, free from blow holes and other imperfections andwhen compared weight for weight with vertically cast pipes, these are appreciably stronger. Spun Pipes have smooth inner surface. Spun iron pipes have therefore practically suspended vertically cast iron pipes.

Indian standard 1537 'Vertically cast iron pressure pipes for water,gas and sewage' provides thefollowing dimensional and other details:

Nominal dia. (DN) mm	D MM	a MM	b MM	s MM	Remark
80	200	40	21	13	Note: Thickness 'e' is equal to the thickness of pipe or fitting comprising the flange. Not toexceed `s' value.
100	220	42	22	13.5	
125	250	44.5	22.5	14.5	
150	285	47	23	15	
200	340	52	24.5	16.5	
250	395	57	26	18	
300	445	61	27.5	19.5	
350	505	66	29	21	
400	565	71	30	22.5	
450	615	76	31.5	24	
500	670	81	33	25.5	
600	780	90	36	28.5	
700	895	100	38.5	31.5	
750	960	105	40	33	
800	1015	110	41.5	34.5	
900	1115	120	44	37.5	
1000	1230	130	47	40.5	

TABLE Dimensions of Flanges of pipes and Fittings (IS 1537)

Nominal Dia. (DN)	Barrel		Wt. of Pipe & Flange		Working Length (L)
	DE M M	e MM	Wt. of one meter pipe (approx) kg	Wt. of one flange (approx) kg	
80	98	7.9	16	3.7	1 to 3
100	118	8.3	20.5	4.2	1 to 4
125	144	8.7	26.4	5.3	1 to 4
150	170	9.2	33.2	6.7	1 to 4
200	222	10.1	48.1	9.3	1 to 4
250	274	11.0	65.0	12.0	1 to 4
300	326	11.9	84.0	14.8	1 to 4
350	378	12.8	105.0	19.0	1 to 4
400	429	13.8	128.7	23.4	1 to 4
450	480	14.7	156.0	26.5	1 to 4
500	532	15.6	181.0	32.1	1 to 4
600	635	17.4	241.4	44.0	1 to 4
700	738	19.3	311.6	59.0	1 to 4
750	790	20.2	348.9	69.8	1 to 4
800	842	21.1	389.1	80.8	1 to 4
900	945	22.9	474.3	94.6	1 to 4
1000	1048	24.8	570.0	120.0	1 to 4

TABLE Flanged Pipes Vertically Cast/Sand Cast Class A (IS – 1537)

Nominal Dia. (DN) mm	Barrel		Wt. of Pipe and Flange		Working Length (L) m
	DE M M	e MM	Wt. of one meter pipe (approx) kg	Wt. of one flange (approx) kg	
80	98	7.9	16	3.7	1 to 3
100	118	9.0	22	4.2	1 to 4
125	144	9.5	28.7	5.3	1 to 4
150	170	10.0	35.9	6.7	1 to 4
200	222	11.0	52.1	9.3	1 to 4
250	274	12.0	70.6	12.0	1 to 4
300	326	13.0	91.4	14.8	1 to 4
350	378	14.0	114.5	19.0	1 to 4
400	429	15.0	139.5	23.4	1 to 4
450	480	16.0	169.0	26.5	1 to 4

500	532	17.0	181.0	32.1	1 to 4
600	635	19.0	241.4	44.0	1 to 4
700	738	21.0	311.6	59.0	1 to 4
750	790	22.0	348.9	69.8	1 to 4
800	842	23.0	389.1	80.8	1 to 4
900	945	25.0	474.3	94.6	1 to 4
1000	1048	27.0	570.0	120.0	1 to 4

TABLE Flanged Pipes Vertically Cast/Sand Cast Class B (IS – 1537)

Note:
The length would depend upon manufacturer's facility.

Flanged pipes horizontally cast may be manufacture with increase in thickness upto the thickness ofcorresponding fitting.

Nominal Dia.	**Test Pressure in Kg/ cm2**			
	Socket & Spigot Pipes		**Flanged Pipes**	
	Class A	**Class B**	**Class A**	**Class B**
Upto & including 300mm	20	25	20	25
Over 300 mm upto 600mm	20	25	15	20
Over 600 mm upto1000 mm	15	20	10	15
Over 1000 mm upto1500 mm	10	15	10	10

Table Hydraulic Test Pressure for Vertically Cast Iron Pipes (IS 1537)

Note: Max. working pressure not less than that of works test pressure.

Nominal Dia.	Total Working for one working length (L) in metres				
	3.66	4	4.88	5	5.5
MM	Kg	Kg	Kg	Kg	Kg
80	64	69.5	----	85.5	-----
100	82	89	----	109	120
125	106	115	----	141	155
150	133	144	----	178	194

MMRDA

200	193	209	251	257	281
250	261	283	340	348	380
300	337	366	440	450	492
350	442	458	550	563	615
400	517	561	674	690	754
450	627	680	817	836	914
500	728	790	949	971	1061
600	973	1055	1267	1296	1417
700	1257	1363	------	1675	1830
750	1409	1527	------	1876	2051
800	1568	1704	------	2093	2288
900	1917	2080	------	2554	2791
1000	2303	2502	------	3072	3357

Table Dimensions and weights of Socket and Spigot Vertically Cast Iron Pipes Class A (IS1537)

Nominal Dia.	Total Working for one working length (L) in metres				
MM	3.66	4	4.88	5	5.5
	Kg	Kg	Kg	Kg	Kg
80	69	74.5	----	92	-----
100	88	95	----	117	128
125	114	124	----	153	167
150	143	155	----	191	209
200	207	225	271	278	304
250	281	305	368	376	411
300	364	395	476	487	533
350	457	495	596	610	667
400	557	604	727	714	814
450	675	732	881	901	986
500	786	853	1026	1049	1148
600	1052	1145	1372	1404	1535
700	1355	1470	------	1808	1977
750	1525	1644	------	2035	2225
800	1696	1840	------	2263	2475
900	2073	2249	------	2766	3024
1000	2489	2699	------	3318	3628

Table Dimensions and weights of Socket and Spigot Vertically Cast Iron Pipes Class B (IS 1537)

2.2 Centrifugally Cast (Spun) Ductile Iron Pressure Pipes for Drainage

Conforming to IS 8329/2000-III Revision and updated in respect of International specifications particularly EN 545/1994, ISO 2531 / 1998.

Fittings shall conform to Indian standard IS-9523 for pressure pipes.

Fittings conforming to IS 13382/1992 for Mechanical and Push-on flexible joints for pressure pipe lines

Length: For flanged pipes, the effective length shall be equal to overall length. For socketed pipes the effective length shall be equal to the over length minus spigot insertion depth.

Classification : Pipes classified as K7, K8, K9, K10, K12... depending on the service conditionsand manufacturing process.

For screwed or welded on flange pipes, the minimum classes as per working pressure criteria shall be as given below:

Minimum class for Ductile Iron Flanged Pipes (8329-2000)

Nominal Dia	Screwed on Flange Minimum				Welded on Flange Minimum			
	PN10	PN16	PN25	PN40	PN10	PN16	PN25	PN40
80-450	K9	K9	K9	K9	K9	K9	K9	K9
500-600	K10	K10	K10	K10	K9	K9	K9	K10
700-1200	K10	K10	K10	-	K9	K9	K9	-
1400-2000	K10	K10	-	-	K9	K9	-	-

Type of Joints

Push-on Joints : For these joints, the spigot ends shall be suitably chamfered or rounded off forsmooth entry of pipe in the sockets fitted with rubber gasket.

For high pressure mains where working pressure is substantial, depending upon the site conditions, suitable joints may be preferred where the joints is restrained against axial movement.

Flanged joints : The dimension and tolerances of flanges shall be such, so as to ensure the inter connection between all flanged components (pipes, fittings, valves) of same DN and PN.

Flanged joints for working pressure on PN ratings of 1.0, 1.6, 2.5 and 4.0 MPa may be screwedflange type or flanges may be welded on plain ended ductile iron pipes.

Flanges shall be at right angle to the axis of pipes and machined on face. The bolt holes shall be drilled.

DI pipes having screwed on flanges shall be sealed at the threaded joint between the pipe and the flange by a suitable sealing compound.

Welding Electrodes: The standard specifies shielded Nickel Iron electrodes as the preferred material for manual arc welding. Electrodes of 3.25 mm or 4 mm dia be used.

Rubber Gasket: Rubber gasket for use with push-on joints or mechanical joints shall conform toIS-5382. Rubber gaskets for use with flanged joints shall conform to IS-638.
Tensile Test: Test results shall comply with the requirement given in the table 113.Table 113 Tensile strengths of DI pipes (IS-8329/2000)

Nominal Dia (DN) mm	Max. Tensile strength MPa	Min. elongation at break%
80-1000	420	10
1100-2000	420	7

Hydrostatic Test : All pipes shall be tested hydrostatically at pressure specified in table 114. Pressure shall be applied internally and shall be steadily maintained for a period of minimum 10seconds. The pipe shall withstand the pressure test and shall not show any sign of leakage, sweating or other defects of any kind.

Table 119 provides Max. site test pressure and max. working pressure for various classes of pipes.

Length : The standard working length of socket and spigot pipes shall be 4m, 5m, 5.5m, and 6.0m and for flanged pipes shall be 4m, 5m, and 5.5m.

Table 114 Hydrostatic Test Pressure at Works for Ductile Iron Pipes MPa (IS-8329/2000) – Minimum).

Nominal Dia mm	D.I. Pipes with flexible Joints			Pipes with screwed or welded onflanges			
	Class K7	Class K8	Class K7, K8,K9,K10, K12	PN10	PN16	PN25	PN40
80 to 300	3.2	4.0	5.0	1.6	2.5	3.2	4.0
350 to 600	2.5	3.2	4.0	1.6	2.5	3.2	4.0
700 to 1000	1.8	2.5	3.2	1.6	2.5	3.2	-
1100 to 2000	1.2	1.8	2.5	1.6	2.5	2.5	-

Note : Practical considerations limit the works hydrostatic test pressure to values which may be lower than the site test pressure.

Wall Thickness : The nominal wall thickness of DI pipes socket andspigot are as under:

Table 115 Wall Thickness of Ductile Iron Pipes. (IS-8329/2000)

Nom. Dia (DN) mm	Barrel wall thickness 'e'			
	Class K7	Class K8	Class K9	Class K10

80	5	6	6.0	6
100	5	6	6.0	6.1
125	5	6	6.0	6.3
150	5	6	6.0	6.5
200	5	6	6.3	7.0
250	5.3	6	6.8	7.5
300	5.6	6.4	7.2	8.0
350	6.0	6.8	7.7	8.5
400	6.3	7.2	8.1	9.0
450	6.6	7.6	8.6	9.5
500	7.0	8.0	9.0	10.0
600	7.7	8.8	9.9	11.0
700	9.0	9.6	10.8	12.0
750	9.7	10.0	11.3	12.5
800	10.4	10.4	11.7	13.0
900	11.2	11.2	12.6	14.0
1000	12.0	12.0	13.5	15.0

Weights of Ductile Iron Pipe
Table 116 in respect of class K9 is based on IS-8329/1994 version for general guidance.

Dimensions of Standard Flange Drilling for Screwed Flanges and Welded on flanges
The standard flange drilling shall be as per IS-1538. For standard flange drilling dimensional details refer table 85 to size from 80 mm to 300 mm and table 90 for size 350 mm to 1000 mm.

Minimum class for ductile iron flanged pipe with screwed and welded on flanges shall be as given above. Unless specified otherwise flanges shall be of ductile iron.

Tolerance on thickness: Tolerance on wall thickness 'e' and the flange thickness 'b' of the pipeshall be as follows.

Dimension Tolerance in mm
Wall thickness 'e' upto 6mm- 1.3
Wall thickness 'e' above 6mm- (1.3 + 0.001 DN)
Flange thickness 'b'+ (2 + 0.05b)

Coating: Pipe shall be normally delivered internally and externally coated.

External Protection: By agreement between the manufacturer and the purchaser any one of the following protective coating may be applied depending upon external conditions of use.

Coating: Metallic Zinc rich paint not less than 130 g/m2 with a local minimum of 100 b/m2 or Bitumen coating with mean thickness not less than 70µ m or Polythene sleeving

of density between 910 and 930 kg/m3.

Table 116 Socket and Spigot Ductile Iron Pipes, Class K9. (IS-8329/1994) Total Mass for One **Working Length**

Nominal Diameter DN mm (1)	Barrel		Socket Mass Kg (4)	Total Mass for One Working Length			
	e m m(2)	Mass / mKg (3)		4 m Kg (5)	5 m Kg (6)	5.5 m Kg(7)	6 m Kg (8)
80	6	12.2	3.4	52	65	71	76
100	6.1	15.1	4.3	65	80	88	95
125	6.2	18.9	5.7	82	100	110	119
150	6.3	22.8	7.1	99	121	133	144
200	6.4	30.6	10.3	133	163	179	194
250	6.8	40.2	14.2	175	215	235	255
300	7.2	50.8	18.6	222	273	298	323
350	7.7	63.2	23.7	277	340	371	403
400	8.1	75.5	29.3	331	407	445	482
450	8.5	89.8	36.0	395	485	530	575
500	9.0	104.3	42.8	460	564	616	669
600	9.9	137.3	59.3	608	745	813	882
700	10.8	173.9	79.1	775	949	1036	1123
750	11.3	194.9	90.8	870	1065	1163	1260
800	11.7	215.2	102.6	963	1179	1286	1394
900	12.6	260.2	129.9	1171	1431	1561	1691
1000	13.5	309.3	161.3	1399	1708	1862	2017
1100	14.4	362.8	200.0	1651	2014	2195	2377
1200	15.3	420.1	237.7	1918	2338	2548	2758
1400	17.1	547.2	279.3	2468	3015	3289	3563
1600	18.9	690.3	375.4	3137	3827	4172	4517
1800	20.7	850.1	490.6	3891	4741	5166	5591
2000	22.5	1026.3	626.4	4732	5758	6271	6784

Seal Coat: When specified, cement lining shall be given a seal coat of bituminous material compatible with cement mortar lining.

Internal Lining: By Agreement between the manufacturer and the purchaser, the followinglining may be provided depending upon internal conditions of use.

- Portal cement (IS-8112 or IS-455)
- Blast Furnace slag cement mortar sulfate resisting cement IS 12330 or IS 6909
- High alumina (calcium aluminate) cement mortar IS-6452
- Bituminous paint

Marking: Each pipe shall have cast, stamped or legibly and indelibly painted on it the following appropriate marks.

- Indicating the source of manufacturing
- The nominal dia
- Class reference
- Last 2 digits of the year of manufacture
- A short white line at the spigot end at each pipe with push-on joints in size DN 700 andabove to indicate the major axis of spigot.
- Pipe shall also be marked with standard mark.

Hydrostatic Test Pressure and Hydraulic Working Pressure : Suggested maximum hydrostatic site test pressures and maximum hydraulic working pressures may be followed as given in table 119.

Hydrostatics Site Test Pressure and Hydraulic Working Pressure

(IS-8329/2000, Amendment 1 September 2001)

DN (mm)	Allowable Operating Pressure (excluding surge) AOP				Allowable Maximum Operating Pressure (including surge) MOP				Allowable Site Test Pressure (STP)			
	K7	K8	K9	K10	K7	K8	K9	K 10	K7	K8	K9	K10
	MPa				MPa				MPa			
80	0.8	6.4	6.4	6.4	1.25	7.7	7.7	7.7	1.75	9.6	9.6	9.6
100	0.8	6.4	6.4	6.4	1.25	7.7	7.7	7.7	1.75	9.6	9.6	9.6
125	0.8	6.4	6.4	6.4	1.25	7.7	7.7	7.7	1.75	9.6	9.6	9.6
150	0.8	6.4	6.4	6.4	1.25	7.7	7.7	7.7	1.75	9.6	9.6	9.6
200	0.8	1.0	6.2	6.4	1.25	1.5	7.4	7.7	1.75	2.0	7.9	9.6
250	0.8	1.0	5.4	6.1	1.25	1.5	6.5	7.3	1.75	2.0	7.0	7.8
300	0.8	1.0	4.9	5.6	1.25	1.5	5.9	6.7	1.75	2.0	6.4	7.2
350	0.8	1.0	4.5	5.1	1.25	1.5	5.4	6.1	1.75	2.0	5.9	6.6
400	0.8	1.0	4.2	4.8	1.25	1.5	5.1	5.8	1.75	2.0	5.9	6.3
450	0.8	1.0	4.0	4.5	1.25	1.5	4.8	5.4	1.75	2.0	5.3	5.9
500	0.8	1.0	3.8	4.4	1.25	1.5	4.6	5.3	1.75	2.0	5.1	5.8
600	0.8	1.0	3.6	4.1	1.25	1.5	4.3	4.9	1.75	2.0	4.5	5.4
700	0.8	1.0	3.4	3.8	1.25	1.5	4.1	4.6	1.75	2.0	4.6	5.1
750	0.8	1.0	3.3	3.7	1.25	1.5	3.9	4.4	1.75	2.0	4.4	4.9
800	1.0	1.0	3.2	3.6	1.5	1.5	3.8	4.3	2.0	2.0	4.3	4.8
900	1.0	1.0	3.1	3.5	1.5	1.5	3.7	4.2	2.0	2.0	4.2	4.7
1000	1.0	1.0	3.0	3.4	1.5	1.5	3.6	4.1	2.0	2.0	4.1	4.6
1100	2.9	2.9	2.9	3.2	3.5	3.5	3.5	3.8	4.0	4.0	4.0	4.6
1200	2.8	2.8	2.8	3.2	3.4	3.4	3.4	3.8	3.9	3.9	3.9	4.6

1400	2.8	2.8	2.8	3.1	3.3	3.3	3.3	3.7	3.8	3.8	3.8	4.0
1600	2.7	2.7	2.7	3.0	3.2	3.2	3.2	3.6	3.7	3.7	3.7	4.0
1800	2.6	2.6	2.6	3.0	3.1	3.1	3.1	3.6	3.6	3.6	3.6	4.0
2000	2.6	2.6	2.6	2.9	3.1	3.1	3.1	3.5	3.6	3.6	3.6	4.0

2.3 Ductile Iron Fitting for Pressure Pipes for Drainage

Conforming to IS 9523 First Revision and updated in respect of International specifications BSEN 545/1995 and JIS 5527 have been considered.

Tensile Test: Tensile test shall satisfy the following requirements.

DN-mm Tensile Strength Min. MPa

All sizes 420

Joints:

1) In case of push-on joints of DN 600 and above, the socket may be with or without centeringring.
2) (2) In case of flanged joints castings, the flange shall be at right angle to the axis of joint.

3) The flanges shall be plain faced or with raised boss as specified over the contact surfacewith a tool mark finishing having a pitch of 1+0.3 mm, serrations may be spiral or concentric.

Joints:

4) For high pressure mains, over working pressure 1.6 MPa, suitable flexible joint may bepreferred where the joint is restrained against axial movement.

Rubber Joints: These shall conform to IS 5382.

Hydrostatic Test: The castings shall be kept under pressure for 15 seconds and may be struckmoderately with 700 g hammer. They shall with stand the pressure test without showing any sign of leakage, sweating or other defects of any kind. The castings shall withstand the hydrostatic pressure given in table 120.

Table 120 Hydrostatic Test Pressure for Castings

Nominal Dia DN (mm)	Hydrostatic Test Pressure atWorks, MPa
Upto of including 300	2.5
Over 300 and upto & including 600	1.6
Over 600 and upto and including 2000	1.0

Note: Works test pressure is less for fittings than for pipes because the shape of fittings

makes it difficult to provide sufficient restraint to high internal pressure during test.

Dimension of Standard Flange Drilling for Flanged Fitting PN10:
For dimension of standard flange drilling for flange fittings refer table 85 for sizes from 80 mm to 300 mm and table 90 for sizes 350 mm to 1000 mm.

Coating: Fittings and accessories shall be normally delivered internally and externally coated.

External Coating: By agreement between manufacturer and purchaser. Metallic Zinc, Zinc richpaint, Bituminous Paint and External Sleeving.

Internal Lining: By agreement Potable Cement, Blast Furnace Slag Cement, High Alumina Cement mortar, Cement mortar with seal coat and bituminous paint may be applied. Lining thickness is 3.0 mm upto DN 300 and 5.0 mm for size 350 mm to 600 mm.

Fittings are also zinc coated when specified

Marking: Each casting shall have cast, stamped or indelibly painted on it the following appropriate mark.

a) Source of manufacture.
b) Nominal dia
c) PN rating of flange when applicable
d) May also be marked with standard mark

2.3.1 Range of Special Castings:

Following range of special castings shall be used as applicable:

1. Double Socket Bends 90°, 45°, 22½°, 11¼°
2. Duck Foot Bend 90°, double socket
3. Double Socket Concentric Tapers
4. All Socket Tees
5. Flanged on Double Socket Tee (PN 16) is preferred flange PN 25 and PN 40 are suppliedwhen specified.
6. Collars K12 (For operational convenience, collars are with mechanical joints only)
7. Flanged Socket class K12 (PN16) is the preferred flange PN 25 & PN 40 are supplied whenspecified.
8. Flanged Spigot class K12 (PN 16 is the preferred flange PN 25 & PN 40 flanges aresupplied when specified.
9. Blank Flange – Type PN 16 (PN 16 is the preferred range PN 25 & PN 40 are supplied whenspecified)
10. Double Flanged Bends : 90°, 45°
11. Duck Foot Bend Double Flanged-90°
12. All Flanged Tee of different size (PN16 is the preferred flange. PN 25 and PN 40 aresupplied when specified)
13. Double Flanged Concentric Tapers of various sizes (PN 16 is preferred flange PN 25 andPN 40 are supplied when specified)

2.3.2 CI Hub less Pipes & Fittings:

Cast Iron Pipe and Fitting:
Pipes and fittings comply with all points of EN 877/BIS:15905 (last edition)

The stamps and marks of quality (NF, BBA, Ü...) delivered by standardization associations and controlled by third party laboratories are visible on products. This assures that products conformto controlled by third party laboratories are visible on products. This assures that products conform to all points of EN 877 (last edition)

Pipe are spun with the **deLavaud spinning process** ensuring superior mechanical characteristics such as Tensile strength of 300 MPa, Ring crush strength of 470 MPa and BrinellHardness of 205 HB (Averages Values for DN 100 pipe)

Fitting are coated with brown red epoxy applied by cataphoresis process with an average 70 microns thickness (mini 40 microns)

The General performance requirements of the cast iron systems, their layout and calculation, installation and testing, instructions for operations, maintenance and use meet the requirementsof EN 12056 -1- 5 last edition.

For below ground applications outside coatings are reinforced. According to this, pipes are externally zinc coated at 130 gr /m2 or are covered with bituminous wrapping tape and fittings are coated with 300 microns epoxy.

Joint (Couplings) and Accessories:
Joint and accessories comply with all requirements of EN877 last edition, including EN 681-1 forelastomeric seals (rubber gaskets).

The Stamps and marks of quality (NF, BBA, Ü...) delivered by Standards

Organization companies and controlled by third party laboratories are visible on the products. This assures that the products conform to all points of EN 877 (last edition).

- For below ground applications, couplings have all their steel components made of stainlesssteels.

2.3.3 Jointing:

The shielded coupling for hub less cast iron soil pipe and fittings provides a more compact installation without sacrificing the quality and performance of cast iron. The hub less coupling system typically uses a one-piece. The shielded coupling for hub less cast iron soil pipe and fittings provides a more compact installation without sacrificing the quality and performance of cast iron. The hub less coupling system typically uses a one-piece. The shielded coupling for hub less cast iron soil pipe and fittings provides a more compact installation without sacrificing the quality and performance of cast iron. The shielded coupling for hub less cast iron soil pipe and fittings provides a more compact installation without sacrificing the quality and performanceof cast

iron. The hub less coupling system typically uses a one-piece neoprene gasket and a shield of stainless steel retaining clamps. Hub less couplings are manufactured in accordance with CISPI 310, ASTM C 1277, and ASTM C 1540. Charlotte Super Duty couplings conform to ASTM C 1540. The great advantage of the system is that it permits joints to be made in limited access areas. The 300 series stainless steel, which is always used with hub less couplings, was selected because of its superior corrosion resistance. It is resistant to oxidation, warping and deformation, offers rigidity under tension with substantial tension strength, and yet provides sufficient flexibility. The shield is corrugated in order to grip the gasket sleeve and give maximum compression distribution to the joint. The stainless steel worm gear clamps compress the neoprene gasket to seal the joint. The neoprene gasket absorbs shock, vibration and completely eliminates galvanic action between cast iron and the stainless steel shield. Neoprene will not support combustion and can be safely used up 212° F. The neoprene sleeve is completely protected by a nonflammable stainless steel shield, and as a result a fire rating is not required. Joint deflection using a shielded hub less coupling has a maximum limit of up to 5 degrees. Maximum deflection should not exceed 1/2 inch per foot of pipe. This would allow 5 inches of deflection for a 10 foot piece of pipe. Installation should initially be completed in a straight line and then deflect to appropriate amount. This helps assure a good tight joint. For more than 5 degrees of deflection, fittings should be used.

2.3.4 Testing:

Horizontal piping system shall be tested with a head of minimum 3.0 meters on the highest end with all other open ends plugged for a period of 2 hours. All the joints in the piping system undertesting shall be visually inspected and any drop in the head during the test period shall be monitored. If any leakage/seepage is observed at any of the joint the coupling shall be tightened properly so as to arrest Leakage/seepage.

Vertical Stacks shall be tested with smoke using smoke testing machine with all open ends plugged. Smoke shall be inserted from the bottom most point of the stack. All the joints shall be visually inspected during the test. If any leakage/seepage is observed at any of the joint the coupling shall be tightened properly so as to arrest Leakage/seepage.

2.3.5 Galvanized Iron Pipes

Waste pipes of 50 mm dia and below and where called for shall be galvanised iron pipes screwed and socketed conforming to the requirements of BIS:1239 of heavy grade. The pipes and sockets shall be cleanly finished, well galvanised in and out and free from cracks, surface flaws, laminations and other defects. All screw thread shall be clean and well cut. All pipes and fittings shall bear manufacturer's trade mark and conform to the IS as specified.

2.3.6 UPVC Pipes and Fittings

The pipes shall be round and shall be supplied in straight lengths with socketed ends. The internal and external surfaces of pipes shall be smooth

clean, free from groovings and other defects. The ends shall be cleanly cut and square with the axis of the pipe. The pipes shall be designed by external diameter and shall conform to BIS:4985-1981 or BIS:13592. The pipes shall be of Class-III; 6 Kg/sq.cm pressure rating or type B.

2.3.7 Fittings

Fittings shall be of the same make as that of pipes, injection moulded and shall conform to BIS:14735.

2.3.8 Laying and Jointing

The pipes shall be laid and clamped to wooden plugs fixed above the surface of the wall. Alternatively, plastic clamps of suitable designs shall be preferred. Provision shall be made for the effect of thermal movement by not gripping or disturbing the pipe at supports between the anchors for suspended pipes. The supports shall allow the repeated movements to take place without abrasion. Jointing for UPVC pipes shall be made by means of solvent cement for horizontal lines and 'O' rubber ring for vertical line. The type of joint shall be used as per site conditions / direction of the Owner's site representative. Where UPVC pipes are to be used for rain water pipes, the pipe shall be finished with GI adopter for insertion in the RCC slab for a water proof joint complete asdirected by Owner's site representative.

2.3.9 Supports

UPVC pipes require supports at close intervals. Recommended support spacing for unplasticised PVC pipes is 1400 mm for pipes 50 mm dia and above. Pipes shall be aligned properly before fixing them on the wooden plugs with clamps. Even if the wooden plugs are fixedusing a plumb line, pipe shall also be checked for its alignment before clamping, piping shall be properly supported on, or suspended from clamps, hangers as specified and as required. The Contractor shall adequately design all the brackets, saddles, anchors, clamps and hangers and be responsible for their structural sufficiency. Pipe supports shall be primer coated with rust preventive paint.

2.3.10 Repairs

While temporary or emergency repairs may be made to the damaged pipes, permanent repairs shall be made by replacement of the damaged section. If any split or chip out occur in the wall ofthe pipe, a short piece of pipe of sufficient length to cover the damaged portion of the pipe is cut.The sleeve is cut longitudinally and heated sufficiently to soften it so that it may be slipped over the damaged hard pipe.

2.3.11 uPVC SWR Pipes & Fittings

PVC (SWR) class pipes of dia 75 mm, 110 mm and 160 mm, of Type A for use in rain water (unless otherwise specified) and of Type B for soil, waste and ventilation system and conformingto IS 13592: 1992, shall be used. The pipes shall be supplied in nominal lengths of 2,3,4 or 6 meters, tolerance on specified lengths shall be +10 mm and – 0 mm. Any physical testrequirements shall be as per IS 13592-1992.

2.3.12 Handling

Because of their lightweight, there may be a tendency for the PVC pipes to be thrown much more. Reasonable care should be taken in handling and storage to prevent damage to the pipes. The pipes shall be stored as per manufacturer's specification. The contractor will hold full responsibility in this case. On no account the pipes should be dragged on the ground. Pipes should be given adequate supports at all times.

2.3.13 Laying

The PVC pipes shall be laid under the floors below slab or on walls either buried or exposed as the case may be, as shown in the drawings. The minimum thickness of fittings shall be of 3.2 mm. the fittings shall be of injection mould type with solvent cement joint or rubber ring joint. The pipes and fittings shall be capable of withstanding sun's rays. PVC pipes laid below slab or suspended in ceiling shall be supported by angle brackets / supports as detailed in the drawings.All pipes laid under Floor/ Suspended Ceiling shall be solvent Cement Joint. All Pipes laid vertically in shafts and other areas shall be rubber Ring Joint.

2.3.14 Jointing

The jointing of pipes to fittings shall be done as per the manufacturer's instructions / recommendations. The PVC pipes and fittings shall be joined with Solvent Cement and jointing shall be carried out as follows:

Cut the spigot end of the pipe square.
All burrs from the internal and external surfaces should be removed.

The spigot should be marked with a pencil line and a distance equivalent to the socket depth. Clean the surface within the marked area.

Apply uniform coat of solvent cement on the external surface to the pipe and a lighter coat on the internal surface of the fitting.

Insert the pipe end into the socket of the fitting and push it in upto the mark. Remove the excesssolvent cement and hold the joint firmly in position for 30 seconds to dry. Gluing should be avoided in a rainy or foggy weather. The other method of jointing shall be by rubber rings. The material of rubber ring should conform to IS 5382-1969. The ring is housed in groove formed in a plastic or metallic housing. The rubber is compressed and makes a seal between the pipe and housing. Lubricating paste should be applied before compressing the rubber. Where natural rubber rings are used, mineral oil or petrol or grease should be used.

2.3.15 Testing

PVC pipes and fittings assembled shall be tested in accordance with IS 13592 - 1992. The openings of the pipes shall be sealed for the section to be tested. The water column of 5m and shall be maintained for a maximum of 15 minutes. The contractor with the attendance of the Client team shall examine carefully all the joints for leakage.

2.3.16 uPVC Pipes & Fittings

The pipes shall be round, straight lengths with socketed ends, internal and external surfaces of pipes shall free from groovings and other defects. The pipes shall be designed by external diameter and shall conform to IS:4985-1981. The pipes shall be of Class-III; 6 Kg/sqm pressurerating.

2.3.17 Fittings

Fittings shall be of the same make as that of pipes.

Laying and Jointing

The pipes shall be laid and clamped to wooden plugs fixed above the surface of the wall. Provision shall be made for the effect of thermal movement by not gripping or disturbing the pipeat supports between the anchors for suspended pipes. The supports shall allow the repeated movements to take place without abrasion.

Jointing for UPVC pipes shall be made by means of solvent cement for horizontal lines and 'O' rubber ring for vertical line. UPVC pipes used for rainwater pipes, the pipe shall be finished withGI adopter for insertion in the RCC slab for a water proof joint complete.

2.3.18 Supports

Support spacing for unplasticised PVC pipes is 1400 mm for pipes 50 mm dia and above. Pipesshall be aligned properly before clamping, piping shall be properly supported on, or suspended from clamps, hangers as specified and as required. The Contractor shall adequately design support style and shall be responsible for their structural sufficiency. Pipe supports shall be primer coated with rust preventive paint.

2.3.19 Traps

Floor Traps

Floor traps where specified shall be siphon type full bore PP (WHITE), McAlpine, UK having a minimum 50 mm deep seal. All traps are under slung from the slab and shall be adequately supported.

Urinal Traps

Urinal traps shall be siphon type full bore PP (WHITE), McAlpine, UK having a minimum 50 mmdeep seal. All traps are under slung from the slab and shall be adequately supported.

Floor Trap Inlet

Bath room traps and connections shall ensure free and silent flow of discharging water. Where specified, Contractor shall provide a special type of floor or manhole inlet fitting fabricated from GI pipe/uPVC without, with one, two or three inlet sockets welded on side to connect the waste pipe or joint between waste and inlet socket shall be with sealant compound/push-fit as per requirement of the system. Inlet shall be connected to a P or S trap, floor trap inlet and the trapsshall be set in cement concrete blocks where varied in floors as specified without extra charge.

2.3.20 Cleanout Plugs

Floor Clean Out Plug

Clean out plug for soil, waste or rain water pipes laid under floors shall be provided near pipe junctions bends, tees, "Yes" and on straight runs at such intervals as required as per site conditions. Clean out plugs shall terminate flush with the floor levels. They shall be cast brass suitable for the pipe dia. With screwed to a GI socket. The socket shall be joined to the pipe withdrip seal/pipe seal.

Drainage under floor/above floor (service floors, basement ceiling etc.)

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

Socket Pipes

3-layered reinforced polypropylene (PP) sewage pipes, halogen and lead free, with integral push-fit socket and factory-fitted lip ring, tested and monitored according to the Product Standard EN 1852 – 1, having internal layer of PP in light grey color, intermediate layer of PP ingrey/titanium-grey color, external layer of PP in copper brown color.

Fittings

3-layered reinforced polypropylene (PP) sewage pipes, halogen and lead free, with integral push-fit socket and factory-fitted lip ring, tested and monitored according to the Product Standard EN 1852 – 1. Fittings upto dimension DN/OD 200 are manufactured by injection molding (1-layer), above DN/OD 200 (250 and above) the fittings are butt or extrusion welded bythe manufacturer. Fabrication of fittings at site shall not be permitted.

Pipe Joints

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

Pipe Protection

Cast iron soil and waste pipes under floor in sunken slabs and in wall chases (when cut specially for the pipe) shall be encased in cement concrete 1:2:4 mix (1 cement : 2 coarse sand: 4 stone aggregate of 12 mm size) 10 cm bed and all around. When pipes are running well above the structural slabs, the encased pipes shall be supported with suitable cement concrete pillars of required height and size at intervals directed by the Project Manager.

Cutting and Making Good

Pipes shall be fixed and tested as building proceeds. The contractor shall provide all necessary holes, cutouts and chases in structural members as building work proceeds.

Wherever holes are cut or left originally they shall be made good with cement concrete 1:2:4 (1 cement : 2 coarse sand : 4 stone aggregate 20 mm nominal size) or cement mortar 1:2 (1 cement : 2 coarse sand). Cured and the surface restored to original condition.

2.4 HDPE Pipes and Fittings

2.4.1 Materials

All pipes and fittings to be HDPE manufactured to DIN 19535, DIN 19537, DIN 8074, DIN 8075 fittings to carry a BBA certificate No. 92/2796.

All materials should be manufactured under a BS 5750 / ISO 9000 approved scheme.

All component parts of the system shall be covered by a manufacturer's warranty.

2.4.2 Installation

All pipes and fittings to be fusion welded by either electro sleeve coupling or butt weld.

Fixed points must be provided at a maximum of 5 metre intervals and / or changes in direction.

Intermediate sliding supports must be provided in accordance with the manufacturer recommendations/ application technique manual

All operatives to be trained in welding and jointing techniques by the manufacturer.

2.4.3 Inspection & testing

The work shall be inspected and tested during installation at agreed stages. All work which will be concealed shall be tested before it is finally enclosed.

Work to be inspected regularly by the manufacturer who is to verify compliance with manufacturer's installation guidelines

2.4.3.1 Cast Iron Class (LA) pipes

All drainage passing under building floor and passing through retaining wall shall be cast iron class(LA) pipes (IS : 1536)

Cast iron class (LA) pipe shall be such that they could be cut, drilled or machined. Pipe centrifugally cast in unlined water cooled moulds shall be heat treated in order to achieve the necessary mechanical properties and to relieve casing stress; provided that the specified mechanical properties are satisfied.

Material

Cast iron pipe shall be centrifugally spun cast iron pipe and conforming to

BIS:1536-1976

Fittings

Fittings shall be used for cast iron class (LA pipes shall conform to BIS:1538-1976). Whenever possible junction from branch pipe shall be made by wyes.

All cast iron water main pipes and fittings shall be manufactured to BIS:1536 of tested quality. The pipes and fittings shall either be spigot and socket type or as called for. The pipes and fittings shall be of uniform material throughout and shall be free from all manufacturing defects.

Joints

Cast iron class (LA) pipe used for soil and waste pipes shall be jointed with sealant joints sufficient skein of jute rope shall be caulked to leave minimum space of 25 mm for the Sealant.

Laying

Fittings used for CI drainage pipe shall conform to BIS:1538-1976. Wherever possible junctionfrom branch pipes shall be made by a Y/tee.

Drip Seal Joints :

Pipe joint sealant shall be used for joining various diameters of C.I. pipes and specials. This sealant replaces the standard lead caulked joints. The application is by homogenously mixing the two pack system in cold condition.

Application Procedure:

Clean the pipe joints thoroughly to ensure it is free from any traces of oil, dirt or any other foreignbody. Mix two parts of sealant thoroughly with an iron flat to get a homogenous compound. * Place Spun yarn in the pipe joint as a filler and then take the required quantity of the compound and push it in the joint with a caulking tool, MS flat / damp finger uniformly all over to obtain a smooth and uniform joint. Dip the fingers in water every often to ensure the compound does notstick to the hands of the workmen, but this will ensure perfect sealing and the smooth surface for the joint cement. (* The compound prepared from the two mixtures is to be used within 30 minutes) Precaution to be taken to wash hands thoroughly with soap before and after use. Preferably use disposable gloves for hand application.

The spigot of pipe of fittings shall be centered in the adjoining socket by caulking. Sufficient turnsof tarred gasket shall be given to leave a depth of 45 mm when the gasket has been caulked tightly home. Joining ring shall be placed round the barrel and against the face of the socket. CIsolvent shall then be pushed to the remainder of the socket.

For lead wool joints the socket shall be caulked with tarred gasket, as explained above. The leadwool shall be inserted into the sockets and tightly caulked home skin by skin with suitable tools and hammers of not less than 2 Kg weight until joint is filled.

2.5 Laying and Jointing System of Cast Iron Pipes:

Conforming to IS 3114/1985 (Code of Practice for laying of Cast Iron Pipes)

Excavation and Preparation of Trenches

General: The trench shall be so dug that the pipe may be laid to the required alignment and at arequired depth. When the pipeline is under roadway, a minimum cover of 1.0 m is recommendedfor adoption but it may be modified to suit local conditions.

Width of Trench: The width of trench at the bottom shall be such as to provide not less than 20cm clearance on the either side of pipe.

Additional width shall be provided at positions of sockets and flanges for jointing to be made properly. Depth of pits at such places shall also be sufficient to permit finishing of joints.

Boulders and large stones shall be removed to provide a clearance of atleast 15 cm below and on each side of pipe, valves and fittings for pipes 600 mm in dia or less and 20 cm for pipe largerthan 600 cm in dia.

Trimming of Trench Bottom: Before laying the pipe, bottom of pipe trench shall be properly trimmed off to present a plain surface and all irregularities shall be levelled. Where rock or boulders are encountered, the trench shall be trimmed to a depth of atleast 8 cms. Below the level at which the bottom of barrel of the pipe is to be laid and filled to a like depth with stones broken to pass through a sieve of 12.5 mm aperture size and well rammed to form a fair and clean bed for pipes.

Laying of Pipes

Unloading of Pipes: While unloading, pipes shall not be thrown down from the trucks on hard roads. In order to avoid damage to the pipes and especially to the spigot ends, pipes should notbe dragged along concrete and similar pavements with hard surfaces.

Lowering of Pipes and Fittings: All pipes, fittings, valves and hydrants shall be carefully lowered into trench, piece by piece by means of a derrick, or ropes or other

suitable tools or equipment so as to prevent damage to pipes, fittings, protective coatings and linings. Pipes over300 mm dia shall be handled and lowered into trenches with the help of chain pulley blocks.

Detection of Cracks in Pipes: Any negligence during unloading and handling of pipes results indamage to the pipes and development of hair cracks, which if during hydraulic testing causing havoc particularly in severe in habituated area of hilly regions with population on valley side.

The pipes, therefore, shall be inspected for defects, by ringing with a light hammer preferably while suspended to detect cracks. If doubt persists further confirmation may be obtained by passing a little kerosene which seeps through and shown on the outer surface. Any pipe found the unsuitable after inspection before laying shall be rejected.

Cleaning of Pipes and Fittings: The outside of the spigot and inside of the socket shall be wirebrushed and wiped clean and dry and free from oil and grease before pipe is laid.

Laying Pipe: Every precaution shall be taken to prevent foreign material from entering the pipewhile it is being placed in the line. During laying operation, no debris, tools, clothing or other materials shall be placed in the pipe.

After placing a length of pipe in the trench, the spigot shall be centered in the socket and the pipe forced home and aligned to the gradients.

At times when pipe laying is not in progress, the open ends of the pipes shall be closed by watertight plugs.

Cutting of Pipes: The cutting of pipe for inserting valves, fittings or closure pieces shall be donein a neat and workman like manner, so as to leave a smooth and a right angle to the axis of the pipe. For this purpose use of pipe cutting method may be permitted using a carbon or steel rod. Flame cutting by means of an oxyacetylene torch shall not be followed.

Direction of Laying of Socket End: On level ground, the socket ends should face upstream. When the line runs uphill, the socket ends should face the upgrade.

Permissible Deflection in Joints: The deflection allowed at joints shall not exceed 2.5° for leadjoints and incase of rubber joints for 80-300 mm dia 5° and 450 mm to 750 mm dia 4°.

Usage of Anchor and Thrust Blocks in Pipeline: Thrust blocks suitably designed shall be provided wherever necessary to transmit hydraulic pressure. Where hydraulic thrust is in an upward direction, anchor blocks of sufficient height shall be provided to which the pipes shall besecured with steel straps. For design of anchor and thrust blocks refer clause 9.18-(30) for details. For steeply inclined pipes, refer clause 9.22.

Jointing System:

Following are the type of joints employed in cast iron pipes.

Spigot and Socket Joints

Indian Standard 3114, Code of Practice for Laying of Cast Iron Pipes provided the following types of joints:

- Molten lead (under dry conditions).
- Cement Joints.
- Lead Wool (under wet conditions).
- Tyton joints.
- Push-tite joints.

Placing of Yarning material: The spigot end of one pipe shall be forced into the socket end of the preceding one. The hemp yarn shall be placed around the spigot of the pipe and shall be driven tightly against the inside base of the socket with suitable yarning tools. Each strand shall be cut to sufficient length so that the ends will meet without causing overlap. The ends of strandshall meet on the opposite sides of the pipe and not on the top or bottom. Different strands of yarn should be driven home separately.

The spun yarn required for different sizes of pipes is as presented in table 109.

Table 109 Lead and Spun Yarn for different sizes of Pipes (IS 314)

Nominal size ofPipe, mm	Depth of Dripseal Jointmm	Yarn / Joint Kg
80	45	0.10
100	45	0.18
125	45	0.2
150	50	0.2
200	50	0.3
250	50	0.35
300	55	0.45
350	55	0.60
400	55	0.75
450	55	0.95
500	60	1.00
600	60	1.20
700	60	1.35
750	60	1.45

Note: The quantity of lead and spun yarn given in the table are provisional and variation of 20%is permissible.

The above variation are meant both plus and minus. Pipes Hangers, Supports, Clamps

Etc.

All vertical pipes shall be fixed by galvanized clamps and galvanized angle brackets truly vertical. Branch pipes shall be connected to the stack at the same angle as that of the fittings.

No collars shall be used on vertical stacks. Each stack shall be terminated at top with a cowl (terminal guard).

Horizontal pipes running along ceiling shall be fixed on galvanized structural adjustable clamps of special design shown on the drawings or as directed. Horizontal pipes shall be laid to uniformslope and the clamps adjusted to the proper levels so that the pipes fully reset on them.

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

All pipe clamps supports and hangers shall be galvanized. Factory made prefabricated clamps shall be preferred. Contractor may fabricate the clamps of special nature and galvanize them after fabrication but before installation. All nuts, bolts, washers and other fasteners shall be factory galvanized.

Clamps shall be of approved design and fabricated from MS flats (which shall be galvanized after fabrication) of thickness and sizes as per drawings or contractor's shop drawings. Clamps shall be fixed in accordance to manufacturer's details/shop drawings to be submitted by the contractors.

When required to be fixed on RCC columns, walls or beam they shall be fixed with approved type of galvanized expansion anchor fasteners (Dash fasteners) of approved design and size according to load.

Structural clamps e.g.. trapeze or cluster hangers shall be fabricated by electro-welding from MSstructural members e.g. rods, angles, channels flats as per contractors shop drawings shall be galvanized after fabrication. All nuts, bolts and washers shall be galvanized.

Galvanized slotted angle/channel of approved sizes supports on walls shall be provided wherever shown on shop drawings. Angles/channels shall be fixed to brick walls with bolts embedded in cement concrete blocks and to RCC walls with anchor fasteners mentioned above.The spacing of support bolts on support members fixed horizontally shall not exceed 1 m.

2.6 Installation of Soil, Waste & Vent Pipes

Soil, waste & vent pipes in shafts under the floors / suspended below slab shall consist of cast iron pipes as described earlier. Waste pipes from bottle trap to floor/urinal traps for wash basin, urinal and sink shall be GI pipes and fittings.

All Horizontal pipes running below the slab and along the ceiling, shall be fixed on structural adjustable clamps, sturdy hangers of the design as called for in the drawings. The pipes shall belaid in uniform slope and proper levels. All vertical pipes shall be truly vertical fixed by means of stout clamps in two sections, bolted together, built into the walls, wedged and neatly jointed. Thebranch pipes shall be connected to the stack at the

same angle as that of fittings. All connections between soil, waste and ventilating pipes and branch pipes shall be made by using pipe fittings with inspection doors for cleaning. Pipes shall be fixed in a manner as to provide easy accessibility for repair and maintenance and shall not cause obstruction in shafts. Where the horizontal run off the pipe is long or where the pipes cross over building expansion joints etc. suitable allowance shall be provided for any movements in the pipes by means of expansion joint etc. such that any such movement does not damage the installation in any way.

All cast iron pipes and fittings shall be jointed with drip seal / Best Quality pig lead free from impurities confirming to IS 27.

Before jointing, the interior of the socket and exterior of the spigots shall be thoroughly cleaned and dried. The spigot end shall be inserted into the socket right up to the back of the socket andcarefully centered by two or three laps of threaded spun yarn, twisted into ropes of uniform thickness, well caulked into the back of the socket. No piece of yarn shall be shorter than the circumference of the pipe. The jointed pipe line shall be at required levels and alignment. The reminder of the socket is left for the lead caulking. Where the gasket has been tightly held, a jointing ring shall be placed round the barrel against the face of the socket. Molten Lead shall bepoured to the remainder of the socket.

The depth of the lead joints for the cast iron pipes shall be 45 mm for the pipes upto 100 mm dia and 50 mm for the pipes beyond 100 mm dia respectively.

The joint shall not be covered till the pipe line has been tested under pressure. Rest of pipe line shall be covered so as to prevent the expansion and contraction due to variation in temperature.

Rainwater Pipes

All open terraces shall be drained by rain water downtakes.

Rainwater downtakes are separate and independent of the soil and waste system and will discharge into the underground storm water drainage system of the complex.

Rainwater in open courtyards shall be collected in catch basins and connected to the Storm Water Drains.

Any dry weather flow from waste appliances, e.g. AHU's pump rooms, waste water sumps shallconnected to sewers after traps and not in the storm water drainage systems.

Balcony / Planter drainage

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

System Installation

General principle

Follow conditions should be fulfilled before installation:

Complete installation drawings and other technical documents that have been checked by different parties.

Approved installation plan and procedure that have been transferred to installer.

Materials, tools and manpower are ready, to ensure normal installation.

Building structure should be well understood before installation. Coordinating measurements should be made based on design, installation plan, structure construction procedure and other construction work.

Material checking

Specification, type, and function of pipe, fittings, outlets and other materials should accord with design requirements, and should be with documents of quality certification. The require materialswill be calculated by approved Software.

Surface of pipe, fitting and the other materials should be flawless. For HDPE pipe and fitting, nocrack, concave, air bubble and so on can appear on surface.

Material storage and delivery

Pipes, fittings, outlets and the other material should be stored by classification. Pipes should be stored horizontally on the plane floor, fittings, outlets should be stored layer by layer, and the height should better not be too high.

During loading and unloading the HDPE pipe, it is forbidden to impact, throw, break, drag etc.

HDPE pipes should not be exposed under sunshine for long time and be isolated from fire and heat source.

Pipe layout

Rainwater drainage pipes should be installed on right position according to design. Hanged pipecan have no slope.

Access entry should be installed on vertical pipe. Distance between ground and center of accessentry is 1.0 m.

Connection between hanged pipe and vertical pipe should use 45° branch or 90° gradient tee.

Connection between hanged pipe and vertical pipe, vertical pipe and pipes going out of the building, should better use two 45° bends or one 90° bend with R≥4D. Access cleaning cover should be installed at the bottom of vertical pipe.

In high rise building, when HDPE pipes go through wall or floor, fire stopper of fire protection sleeve should be install according to design.

Rainwater pipes should go through the wall and floor covered with metal or plastic sleeves.

For sleeves partly installed inside floor structure, upper part should be 20 mm higher than decoration level; lower part should be the same level as floor bottom.

For sleeves installed inside wall structure, both sides of sleeve should be level with the decoration surface. Gaps between sleeves and pipes should be filled by fire protection material.

During installation, opening of pipes and outlets should be blocked.

When pipes go through building dilatation joint or expansion joint, system supplier should provide detailed technical documents and solution based on features and flections situation of different material of pipes.

Outlets installation

For flat roof, it should better use DN 50 outlets; for roof with gutters and gully, it should better use DN 50, DN 75, or DN 100 outlets.

Outlets that are belongs to the same siphonic drainage system should better be installed at the same horizontal level.

Inlet-water-height of outlets should ensure that the rainwater in the gutter can be drained out.

Outlets installation should be done according to the products guide manual.

During roof structure construction, installation hole for outlets should be reserved in advance. Connection between the edge of outlet and roof should be tight and no leakage after installation.
During installation, rectifier, guided cover and the other special parts of outlets cannot be installed until the completion of roof waterproof treatment, rainwater pipe cleaning, and elimination of sealant that flows into the short pipe.

For outlets installed on steel panel or stainless-steel gutter (gully), can use Argon welding for connection.

If materials of outlets and rainwater pipes are different, flange can be applied for connection.Pipe installation

HDPE pipes should be connected by butt welding and electro welding.

HDPE pipes can be cut by pipe cutting machine. Cutting edge should be vertical to the axes of pipe.

The length of HDPE prefabricated pipe should not be longer than 10m. Connection between prefabricated pipes can be made by electronic sleeve.

The connection joint of metal pipe should fulfill the air hermetic requirements.

Installation of pipes going out of the building
Pipes going out of the building should be HDPE pipe.

Depth of underground rainwater pipes should be below the freezing line, and load above the pipes should be considered.

When burying HDPE pipes, grit layer with thickness is no less than 100 mm should be

laid in thenormal terrene pipe channel.

The end part of underground rainwater pipes that go through the manhole and touch the surfaceof shaft should be coated two times adhesive, and grit, afterwards insert the cement plaster to avoid water leakage.

Installation of fixing parts

HDPE hanged pipes should be fixed by square steel profile. Square steel profile should be suspended on the structure of building along with suspending HDPE pipes. HDPE suspending pipes should be connected on the square steel profile by guide brackets and anchor brackets. The distance of square steel profile suspending points, and the distance between the guide brackets and anchor brackets should accord with the regulation of table below.

The anchor brackets of HDPE hanged pipes are normally set at the beginning, terminal, both sides of tee, and the position of branch pipe. If dimension of HDPE hanged pipe is more than orequal to DN 250, there should be applied two anchor brackets in each fixation point.

The maximum of distance of anchor brackets which are applied in the HDPE vertical pipe is 5m,the maximum of distance of guide brackets is 15 x Dimension

At the bottom of vertical pipe, specific supporting and fastening measurements should be taken to support the bending point.

Checking

General regulation

Siphonic roof drainage system should be jointly checked by main contractor, system

Supplier and other relevant parts. People who check the system should have technical qualification.

Following documents are necessary for checking:

- Installation drawing of Final version and documents registering design & installing change.
- Quality documents for outlets, pipe, fittings, and fixing parts.
- Application manual for materials and installation.
- Checking records during installation for mid-term tests and concealed sections that cannotbe checked when project completed.
- Checking of system components

Outlet:

Outlet installation should meet design requirement. Connection between outlets and roof shouldsealed and ensure no leakage.

No waste materials such as filling material, package, or other construction wastes are left aroundoutlets, so that avoid outlet jam.

If the roof is concrete, the outlet should be protected by 1 m2 and 5 cm thick of washed stones whose dimension is bigger than 12 cm.

Pipes:

The dimension, diameter and quality of pipes should meet the requirement of design. All pipes should meet relevant product standard.

The allowed deflection of pipe installation should be limited within the requirement of national standard 50242-2002 'Checking regulation for the installation quality of piping work'

The distance between checking fittings or flanged-tees on hanged pipe, should meet the requirement of national standard 50242-2002 'Checking regulation for the installation quality of piping work'

Fixing parts:

The installation of fixing parts for hanged pipe, vertical pipe should accord with the requirement in clause 5.4.

Fixing parts should be firmly fixed on the loading structure of the building.

Overflows or overflow system:

No dirt, filling materials and waste construction staff can be left around the over flow.
The position of overflow or overflow system should ensure that water can flow between outlets and overflow or overflow system.

Hermetic checking

Jam all the outlets, fill water into roof or gutters of roof. Water should submerge the outlets for atleast 1 hour, and no leakage should happen around outlet.

For pipes installed inside the building, should also tested by filling water inside the pipe till outlet for at least 1 hour, and no leakage should happen around pipes and all connection points.

Final checking

Roof and gutters should be clean and no dirt is left.
Each water catchments area should have overflow or overflow system that are installed in accordance with design.

Main horizontal and vertical pipes should pass water-filling test. Water should go through smoothly and no jam.

2.7 Traps

2.7.1 Floor Traps

Floor traps where specified shall be siphon type full before P or S type cast iron having a minimum 50 mm deep seal. The trap and waste pipes when buried below ground shall be set and encased in cement concrete blocks firmly supported on firm ground or when installed on a sunken RCC structural slab. The blocks shall be in 1:2:4 mix (1 cement : 2 coarse sand : 4 stoneaggregate 20 mm nominal size).

Contractor shall provide all necessary shuttering and centering for the blocks. Size of the block shall be 30 x 30 cms of the required depth.

2.7.2 Floor Trap Inlet /Hopper

Bathroom traps and connection shall ensure free and silent flow of discharging water. Where specified, contractor shall provide a special type of floor inlet fitting fabricated from GI pipe, withone, two or three inlet sockets welded on side to connect the waste pipe. All joint between waste hopper and CI inlet socket shall be drip seal/Lead Caulked. Inlet shall be connected to a CI "P" trap. Floor trap inlet and the traps shall be set in cement concrete blocks where buried in floors without extra charge. Floor trap for the shower cubicle shall suit site and as per the approval of Owner's site representative. All fabricated hopper shall be hot dip galvanized.

2.7.3 Floor Trap Grating

Floor and urinal traps shall be provided with 100 – 150 mm square or round stainless steel gratings, with frame and rim of approved design and shape or as specified in the schedule of quantities approved by the Owner's site representative.

2.7.4 Cleanout Plugs

Floor Clean Out Plug

Clean out plug for soil, waste or rain water pipes laid under floors shall be provided near pipe junctions bends, tees, "Y" and on straight runs at such intervals as required as per siteconditions. Cleanout plugs shall terminate flush with the floor level. They shall be threaded and provided with key holes for opening. Cleanout plugs shall be cast brass suitable for the pipe dia.With screwed to a GI socket. The socket shall be drip seal joined/ Lead Caulked to the drain pipes.

Cleanout on Drainage Pipes

Cleanout plugs shall be provided on head of each drain and in between at locations indicated onplans or directed by Owner's site representative. Cleanout plugs shall be of size matching the full bore of the pipe but no exceeding 150 mm dia CO plugs on drains of greater diameters shallbe 150 mm dia. Fixed with a suitable reducing adapter.

Floor cleanout plugs shall be cast brass.

Cleanouts provided at ceiling level pipe shall be fixed to a CI flanged tail piece. The cleanout doors shall be specially fabricated from light weight galvanized sheets and angles with hinged type doors with fly nuts, gasket etc. as per drawing.

2.8 Pipe Sleeves

Pipe sleeves, next larger diameter than pipes shall be provided wherever pipes pass through walls & slabs and annular space filled with fiberglass & finished with retainer rings. All pipes shallbe accurately cut to the required sizes in accordance with relevant BIS codes and burrs removedbefore laying. Open ends of the pipe shall be closed as the pipe is installed to avoid entrance offoreign matter.

2.9 Pipe Protection

Cast iron soil and waste pipes under floor in sunken slabs and in wall chases (when cut speciallyfor the pipe) shall be encased in cement concrete 1:2:4 mix (1 cement : 2 coarse sand : 4 stoneaggregate of 12 mm size) 10 cm bed and around. When pipes are running well above the structural slabs, the encased pipes shall be supported with suitable

cement concrete pillars of required height and size at intervals directed by the Project Manager.

2.10 Cutting and Making Good

Pipes shall be fixed and tested as building proceeds. The contractor shall provide all necessary holes, cutouts and chases in structural members as building work proceeds. Wherever holes arecut or left originally they shall be made good with cement concrete 1:2:4 (1 cement : 2 coarse sand : 4 stone aggregate 20 mm nominal size) or cement mortar 1:2 (1 cement : 2 coarse sand). Cured and the surface restored to original condition.

2.11 Painting

Used paint and coatings that comply with the following limits for VOC content and the following chemical restrictions:

- Non-Flat Paints and Coatings: VOC not more than 150 g/L.
- Anti-Corrosive Coatings VOC not more than 250 g/L.
- Aromatic Compounds: Paints and coatings shall not contain more than 1.0 percent by weight total aromatic compounds (hydrocarbon compounds containing one or more benzenerings).
- Paints and coatings shall not contain any of the following:
  - Acrolein
  - Acrylonitrile
  - Antimony
  - Benzene
  - Butyl benzyl phthalate
  - Cadmium
  - Di-2-ethylhexyl Phthalate
  - Di-n-butyl phthalate
  - Di-n-octyl phthalate
  - 1,2-dichlorobenzene
  - Diethyl phthalate
  - Dimethyl phthalate
  - Ethyl benzene

Soil, waste, vent and rain water pipes in exposed location, in shafts shall be painted with two or more coats of ready mix Low – VOC oil paint to give an even shade. Before painting all dust andextraneous matter shall be removed.

Paint shall be of approved quality and shade. Where directed by the Owner's site representativepipes shall be painted in accordance with approved pipe colour code.

Pipe in chase shall be painted with two coats of bitumen paint, covered with polythene tape anda final coat of bitumen paint. Exposed pipes shall be painted with synthetic enamel paint after removing dust and extraneous matter.

C.I. Soil and waste pipes below ground and covered in cement concrete shall not be painted.

2.11.1 Testing

Testing shall be done in accordance with BIS:1172 and BIS:5329 except as may be modified herein under.

Entire drainage system shall be tested for water tightness and smoke tightness during and aftercompletion of the installation. No portion of the system shall remain untested. Contractor must have adequate number of expandable rubber bellow plugs, manometers, smoke testing machines, pipe and fitting work tests,

All materials obtained and used on site must have manufacturer's hydraulic test certificate for each batch of materials used on the site.

Before use at site all CI pipes shall be tested by filling up with water for at least 30 minutes. Afterfilling, pipes shall be struck with a hammer and inspected for blow holes and cracks. All defectivepipes shall be rejected and removed from the site within 48 hours. Pipes with minor sweating may be accepted at the discretion of the Project Manager.

Soil and waste pipes shall be tested in sections after installation, by filling up the stack with water. All openings and connections shall be suitably plugged as approved by the Project Manager. The total head in the stack shall be 4.5 m at the highest point of the section under test.The period of test shall be minimum for 30 minutes or as directed by the Project Manager. If anyleakage is visible, the defective part of the work shall be cut out and made good.

On completion of the work the entire installation shall be tested by smoke testing machine. The test shall be conducted after the plumbing fixtures are installed and all traps have water seal or by plugging the outlets with bellow plugs. Apply dense smoke keeping the top of stack open andobserve for leakages. Rectify or replace defective sections.

After the installation is fully complete, it should be tested by flushing the toilets, running atleast 20% of all taps simultaneously and ensuring that the entire system is self-draining, has no leakages, blockages etc. rectify and replace where required.

A test register shall be maintained, and all entries shall be signed and dated by the Contractor and the Project Manager or his representative.

All pipes in wall chase or meant to be encased or buried shall be hydro tested before the chase in plastered or the pipe encased or buried.

2.12 External Drainage (Sewage & Storm Water Disposal)

2.12.1 General Scheme

The contractor shall install a drainage system to effectively collect; drain and dispose all soil and waste water from various parts of the buildings, appurtenances and equipment. The piping system shall finally terminate and discharge into the STP. The piping work mainly consists of laying of Salt glazed stoneware pipes, reinforced cement concrete pipes and cast iron soil pipesas called for on the drawings. All piping shall be installed at depth greater than 80 cm below finished ground level. The disposal system shall include construction of gully traps, manholes, intercepting chambers as indicated. The piping system shall be vented suitably at the starting point of all branch drains, main drains, the highest/lowest point of drain and at intervals as shown. All ventilating arrangements shall be unobstructed and concealed. The work shall be executed strictly in accordance with BIS: 1742. The sewage system shall be subject to smoke test for its soundness as directed by the Project Manager. Wherever the sewerage pipes run above water supply lines, same shall be completely encased in cement concrete 1:2:4 all round with the prior approval of the Project Manager.

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

Sewer lines including earth work for excavation, disposal, back filling and compaction, pipe lines, manholes, drop connections and connections to the municipal or existing sewer.

Storm water drainage, earth works for excavation, disposal, backfilling and compaction, pipe lines, manholes, catch basins and connections to the existing municipal storm water drain or connected as indicated by the Project Manager.

2.12.2 General Requirements

All materials shall be new and of quality conforming to specifications and subject to the approvalof the Owner's site representative. Wherever particular makes are mentioned, the choice of selection shall remain with the Architect / Consultant / Owner's site representative.

Drainage lines and open drains shall be laid to the required gradients and profiles. All drainage work shall be done in accordance with the local municipal bye-laws.
Contractor shall obtain necessary approval and permission for the drainage system from the municipal or any other competent authority.

Location of all manholes, etc. shall be got confirmed by the Project Manager before the actual execution of work at site. As far as possible, no drains or sewers shall be laid in the middle of road unless otherwise specifically shown on the drawings or directed by the Project Manager in writing.

All materials shall be rust proofed; materials in direct or indirect contact shall be

compatible to prevent electrolytic or chemical (bimetallic) corrosion.

2.13 Trenching for Pipes and Drains

2.13.1 General

All the material shall be new of best quality conforming to specifications and subject to the approval of the Architects. Drainage lines shall be laid to the required gradients and profiles. All drainage work shall be done in accordance with the local municipal by-laws.

Contractor shall obtain necessary approval and permission for the drainage system from the municipal or any other competent authority. Location of all manholes catch basins etc. shall be finalized and shown in approved shop drawings before the actual execution of work at site. All work shall be executed as directed by the Project Manager.

2.13.2 Alignment & Grade

The sewer and storm water drainage pipes shall be carefully laid to levels and gradients shown in the plans and sections but subject to modifications as shall be ordered by the Architects from time to time to meet the requirements of the works. Great care shall be taken to prevent sand etc. from entering the pipes. The pipes between two manholes shall be laid truly in straight lineswithout vertical or horizontal undulations. The body of the pipes shall rest on an even bed in thetrench for its length and places shall be excavated to receive collar for the purpose of jointing. No deviations from the lines, depths of cuttings or gradients as called for on the drawings shall be permitted without the written approval of the Architect. All pipes shall be laid at least 60 cms below the finished ground level or as called for on the drawings.

2.13.3 Setting out Trenches

The contractor shall set out all trenches, manholes, chambers and such other works to true grades and alignments as called for. He shall provide the necessary instruments for setting out and verification for the same. All trenches shall be laid to true grade and in straight lines and as shown on the drawings. The trenches shall be laid to proper levels by the assistance of boning rods and sight rails which shall be fixed at intervals not exceeding 10 meters or as directed by the Project Manager.

2.13.4 Trench Excavation

The trenches for the pipes shall be excavated with bottoms formed to level and gradients as shown on the drawings or as directed by the Project Manager. In soft and filled in ground, the Project Manager may require the trenches to be excavated to a greater depth than the shown onthe drawings and to fill up such additional excavation with concrete (1:4:8) consolidated to bring the excavation to the required levels as shown on the drawings.

All excavations shall be properly protected where necessary by suitable timbering, piling and sheeting as approved by the Project Manager. All timbering and sheeting when withdrawn shall be done gradually to avoid falls. All cavities be adequately filled and consolidated. No blasting shall be allowed without prior approval in writing from the Architect. It shall be carried out under thorough and competent supervision, with the written permission of the appropriate authorities taking full precautions connected with

the blasting operations. All excavated earth shall be kept clear of the trenches to a distance equal to 75 cms.

2.13.5 Timbering of Sewer and Trenches

The Contractor shall at all times support efficiently and effectively the sides of all the trenches and other excavations by suitable timbering, piling and sheeting and they shall be close timbered in loose or sandy strata and below the surface of the sub soil water level.

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

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

2.13.6 Shoring of Buildings

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

2.13.7 Obstruction Road

The contractor shall not occupy or obstruct by his operation more than one half of the width of any road or street and sufficient space shall then be left for public and private transit. He shall remove the materials excavated and bring them back again when the trench is required to be refilled. The contractor shall obtain the consent of the Project Manager in writing before closing any road to vehicular traffic and the foot walks must be clear at all times.

2.13.8 Protection of Pipes etc.

All pipes, water mains, cables etc. met in the course of excavation shall be carefully protected and supported. Care shall be taken not to disturb the cables, the removal of which shall be arranged by the contractor with the written consent from the Project Manager.

2.13.9 Trench Back Filling

Refilling of the trenches shall not be commenced until the length of pipes therein has been tested and approved. All timbering which may be withdrawn safely shall be removed as filling proceeds. Where the pipes are unprotected by concrete hunching, selected fine material shall becarefully hand-packed around the lower half of the pipes so as to buttress them to the sides of the trench.

The refilling shall then be continued to 150 mm over the top of the pipe using selected fine hand packed material, watered and rammed on both sides of the pipes with a wooden hammer. The process of filling and tamping shall proceed evenly in layers not

exceeding 150 mm thickness, each layer being watered and consolidated so as to maintain an equal pressure on both sides ofthe pipe line. In gardens and fields the top solid and turf if any, shall be carefully replaced.

2.13.10 Contractor to restore settlement and Damages

The contractor shall at his own costs and expenses, make good promptly during the whole period for the works in hand if any settlement occurs in the surfaces of roads, beams, footpaths,gardens, open spaces etc. in the public or private areas caused by his trenches or by his other excavations and he shall be liable for any accident caused thereby. He shall also, at his own expense and charges, repair (and make good) any damage done to building and other property. If in the opinion of the Project Manager he fails to make good such works with all practicable dispatch, the Project Manager shall be at his liberty to get the work done by other means and the expenses thereof shall be paid by the contractor or deducted from any money that may be or become due to him or recovered from him by any other manner according to the laws of land.

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

2.13.11 Removal of Water from Sewer, Trench etc.

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

If any excavation is carried out at any point or points to a greater width of the specified cross section of the sewer with its cover, the full width of the trench shall be filled with concrete by thecontractor at his own expense and charges to the requirements of the Project Manager.

2.13.12 Removal of Filth

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

2.13.13 Width of Trench

The Project Manager shall have power by giving an order in writing to the Contractor to increasethe maximum width/depth for excavation and backfilling in trenches for various classes of sewer,manholes and other works in certain length to be specifically laid down by him, where on account of bad ground on other unusual conditions, he considers that such increased width/depths are necessary in view of the site conditions.

2.14 Piping Material

2.15 RCC pipes

All pipes shall be centrifugally spun RCC pipes NP2. 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, prior to use on site, a certificateto that effect from the manufacturer.

The pipes shall be with or without reinforcement as required and of the class as specified. Theseshall conform to BIS:458-1971.

All pipes shall be true to shape, straight, perfectly sound and free from cracks and flaws. The external and internal surface of the pipes shall be smooth and hard. The pipes shall be free fromdefects resulting from imperfect grading of the aggregate mixing or molding.

2.16 Laying

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

2.17 Jointing

Semi flexible type collar joint.
Hemp rope soaked in neat cement wash shall be passed round the joint and inserted in it by means of caulking tool. More skein of yarn shall be added and rammed home. Cement mortar with one part of cement and two part of sand and with minimum water content but on no accountsoft or sloppy, shall be carefully inserted, punched and caulked into the collar and more cementmortar added until the space of the collar has been filled completely with tightly caulked mortar. Provision of rubber sealing ring in the collar joint shall also be made. The joint shall then be finished off neatly outside the socket at an angle of 45 deg.

2.18 Curing:

The joint shall be cured for at least seven days. Refilling at joints will be permitted only on satisfactory completion of curing period.

Cement Concrete for Pipe Supports:

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

	upto 1.5 m depth	upto 3 m depth	beyond 3 m depth
Stoneware pipes buried in open ground (no sub soil water)	All round (1:3:6)	In Haunches (1:3:6)	In Haunches (1:3:6)
RCC or SW in sub soil water	All round (1:3:6)	In Haunches (1:3:6)	In Haunches (1:3:6)
PVC / HDPE pipe	All round (1:2:4)	In Haunches (1:3:6)	In Haunches (1:3:6)
CI Pipes (in all conditions)	All round (1:4:8)	In Haunches (1:4:8)	In Haunches (1:4:8)
All pipes under building	All round (1:2:4)	All round (1:2:4)	All round (1:2:4)

Pipes may be supported on brick masonry or precast RCC or in situ cradles. Cradles shall be asshown on the drawings.

Pipes in loose soil or above ground shall be supported on brick or stone masonry pillars as shown on the drawings.

Measurement:

a. Excavation
Measurement for excavation of pipes trenches shall be made per linear meter.

b. Trenches shall be measurement between outside walls of manholes at top and the depth shall be the average depth between the two ends to the nearest cm. The rate quoted shall be for a depth upto 1.5 metre or as given in the Bill of Quantities.

Payment for trenches more than 1.5 m in depth shall be made for extra depth as givenin the Bill of Quantities and above the rate for depth upto 1.5 m.

c. RCC pipes shall be measured for length of the pipe line per linear meter.

Length between manholes shall be recorded from inside of one manhole or inside of other manhole.

Length between gully trap and manhole shall be recorded between socket of pipe near gully trapand inside of manhole.

2.19 UPVC/Eco Flow Pipes and Fittings

The pipes shall be round and shall be supplied in straight lengths with socketed ends. The internal and external surfaces of pipes shall be smooth, clean, free from groovings and other defects. The ends shall be cleanly cut and square with the axis of the pipe. The pipes shall be designed by external diameter. Eco Flow pipes shall be used for the

load bearing areas.

Fittings

Fittings shall be of the same make as that of pipes, injection moulded and shall conform to Indian Standard.

Laying in Trenches

UPVC pipes shall be laid on cement concrete bed of width 300 mm over the outside diameter ofpipe, and 100 mm thickness. Fine sand shall be carefully filled around the lower half of the pipesso as to buttress them to the sides of the trench.

The filling shall then be continued to 150 mm over the top of the pipe using fine sand, watered and rammed on both sides of the pipes. The process of filling and ramming with fine handpickedmaterial shall proceed evenly in layers not exceeding 150 mm thickness, each layer being watered and consolidated so as to maintain an equal pressure on both sides of the pipe line.

2.20 Cast Iron Class (LA) Pipe:

All drainage line passing under building, floors and roads with heavy traffic shall be Cast Iron Class (LA) Pipe.

Cast Iron Class (LA) pipe shall be such that they could be cut, drilled or machined. Pipe centrifugally cast in unlined water cooled moulds shall be heat treated in order to achieve the necessary mechanical properties and to relieve casting stresses; provide that the specified mechanical properties are satisfied.

Material

Cast iron pipe shall be centrifugally spun cast iron pipes and conforming to BIS:1536-1976.

Fittings

Fittings shall be used for Cast Iron Class (LA) Pipes shall conform to BIS:1538-1976. Wheneverpossible junction from branch pipe shall be made by Wyes.

Laying

Fittings used for CI drainage pipe shall conform to BIS:1538-1976. Whenever possible junction from branches pipes shall be made by a Wyes.

All cast iron pipes and fittings shall be jointed with best quality Dripseal.
The approximate depth and weights of Pig Lead for various diameters of C I pipes and specials shall be as follows:

Nominal Size of PipeMm	Depth of Dripseal Jointmm

80	45
100	45
125	45
150	50
200	50
250	50

The spigot of pipe of fittings shall be centred in the adjoining socket by caulking. Sufficient turnsof tarred gasket shall be given to leave a depth of 45 mm when the gasket has been caulked tightly home. Joining ring shall be placed round the barrel and against the face of the socket. Dripseal to fill the remainder of the socket. This shall then be done in one filling. The Dripseal shall then be solidly caulked with suitable tools and hammers weighting not less than 2 Kgs.

Joints:

Drip seal PJS-43 (pipe joint sealant) shall be used for joining various diameters of C.I. pipes andspecials. This sealant replaces the standard PIG LEAD caulked joints .The application is by homogenously mixing the two pack system in cold condition. Drip seal PJS - 43 is theproprietary item of M/s. Vinod Cement Co., Chandigarh.

Application Procedure:

Clean the pipe joints thoroughly to ensure it is free from any traces of oil, dirt or any other foreignbody. Mix two parts of Drip Seal thoroughly with an iron flat to get a homogenous compound. * Place Spun yarn in the pipe joint as a filler and then take the required quantity of the compound and push it in the joint with a caulking tool, MS flat / damp finger uniformly all over to obtain a smooth and uniform joint. Dip the fingers in water every often to ensure the compound does notstick to the hands of the workmen, but this will ensure perfect sealing and the smooth surface for the joint cement. (* The compound prepared from the two mixtures is to be used within 30 minutes) Precaution to be taken to wash hands thoroughly with soap before and after use. Preferably use disposable gloves for hand application.

Jointing

a) Cement Joints

In case of cast iron pipes used for sewer lines under low pressure, a closely twisted spun yarn gasket of required dia in one piece of sufficient length to pass around the pipe and lap at the topshall be thoroughly saturated in cement paste. This gasket shall be laid in the socket for the lower third of the circumference of the joint and covered with cement mortar. The spigot of the pipe shall be thoroughly cleaned with a wet brush, inserted and carefully driven home, after which a small amount of mortar shall be inserted in the annular space around the entire circumference of the pipe and solidly rammed into the joint with a caulking tool, the mortar previously placed being driven ahead of the gasket. The remainder of the joint shall then be completely filled with mortar and beveled off at an angle of 45° with the outside of the pipe. The joint should be kept wet with neat gunny

bags for 24 hours after making.

Cement joints shall be used only for temporary installations.

b) Tyton Joints (Rubber Ring Joints)

Tyton joint is sturdy push on type joint. The sockets of the pipes to receive tyton joints are specially designed to contain elongated grooved gasket. The inside contour of the socket bell provides a seat for the circular rubber ring in a modified bulb shaped gasket. An internal ridge in the socket fits into the groove of the gasket. A slight taper on the plain end of the pipe facilitates assembly.

The maximum joint deflection angle is 5° for sizes through 4° for 350 mm and 400 mm dia and 3° for 450 mm and 500 mm dia.

The socket and spigot end of the pipe is cleaned first. Thereafter a thin film of lubricant should be applied to the bulb seating inside the socket, but not to the hard rubber heal. Now the gasketshould be held so that it takes a shape of a heart. The gasket is placed in the socket with bulb towards the back of the socket so that the hard rubber heal engages in the retaining groove. If any loop is left it will be pressed flat for proper fit of gasket in the groove. In case it is difficult to press the loop, as it may be in case of larger diameter, a second loop are then pressed flat one after the other. A thick film of lubricant should be applied to the inner side of the gasket where the spigot end will come in contact, to facilitate the entry. The spigot end of the pipe should alsobe lubricated. After centering the spigot should be inserted far enough into the socket to make contact with the gasket. The spigot end is forced into the socket carefully compressing the gasket till the spigot and reaches near the bottom of the socket. If the assembly is not completed with reasonable force, the spigot should be removed and the position of the gasket examined.

c) Push-tite Joints

Push-tite is specially devised moulded rubber ring gasket to fit the socket configuration of cast iron pipes suitable for conventional poured joints. The flange shaped mouth of this gasket is made of harder rubber. It provides a strong shoulder for self-centering of the spigot end at the time of assembly. Push-tite will function effectively under all normal working conditions. While using these joints in the conventional pipes, the ends of the pipes may be given a slight taper tofacilitate assembly of 100 mm dia. Pipes from 80 to 150 mm dia are assembled with fork tool. Larger diameters are done with rack and lever tackle.

2.21 Flanged Joints (Mechanical or bolted joints)

Flanges shall be of two types:

a) Vertically cast flanged pipes conforming to IS-1537 with integral flanges.
b) Centrifugally cast iron pipes with screwed on flanges for class B. as per IS-1536.

The flanges of both the above types of pipes are drilled to IS-1538, unless other-wise specified.

The jointing material used between flanges of pipes shall be compressed fibre board or rubber conforming to IS-1638, specifications of rubber and insertion jointing of thickness

between 1.5 mm to 3 mm. The fibre board shall be impregnated with chemically neutral mineral oil and shall have a smooth and hard surface. Its weight per square meter shall not be less than 112 g/mm thickness.

Each bolt should be tightened a little at a time taking care to tighten diametrically opposite bolts alternatively. The practice of fully tightening the bolts one after another is highly undesirable. No bolt shall be stressed beyond elastic limit and no spanner other than the standard pattern shall be allowed nor shall any appliance for lengthening the leverage of any spanner be permitted. Allflanges with their bolts shall be painted with two coat of pitch or tar.

The compressed fibre gasket should be of such width as to fit inside the circle of bolts. The ringsshall be smeared thinly with graphite paste. Alternatively, the jointing rings may be of rubber insertion or gutta-purcha with a suitable jointing paste.

In addition to flanged pipes and specials, flanged joints are also encountered while fixing flanged joints are also encountered while fixing flanged sluice valves, air valves, hydrants, meter connection which sometime require their removal for repairs. Flanged joints find their applicationin vertical inlet and outlet of pipes of overhead reservoirs, suction pipes of pump where perfectlyair tight joint is required to avoid air being sucked in and also where there are vibrations. Flanged jointing is extensively employed for outside work, overhead pipe lines and also for connection in vertical and confined positions, but are usually not employed for pipe line work below ground like gravity mains etc. Flange joints are expensive and are thus only used for indoor works and under other situations requiring the use of flanged joints as discussed above.

The details of flanges regarding outside dia. thickness weight pitch circle dia (PCD), no of holes,dia of holes and dia of bolts etc. may be read from table 76, 'Dimensions of flanges of pies and fittings, and table 84, 85 and table 90, Standard flange drilling of flanged pipes to IS-1538'.

The flexible mechanical joints (fig. 83) have many advantages such as rapid jointing, adaptabilityto pipe line movements permitting expansion and deflection without causing any damage, thus minimizing height chances of leakage and also possibility of dismantling and reuse resulting in overall saving.

Bolting : The should be provided with washers tapered or otherwise of suitable shape to give the head and nut of the bolt a satisfactory bearing. The thread portion of each bolt shall project through the nut at least one thread. In order to develop full bearing area of the bolt, the bolt shallbe provided with a washer of sufficient thickness under the nut to avoid any thread portion of thebolt being within the thickness of parts bolted together.

The following table gives the length to be added to the grip length to get over all length of the bolt. This does not provide thickness of washer and gasket etc. These need to be added in grip length.

Table 111 Bolt Size & Addition Required to Grip Length

Bolt Size mm	Add to grip length mm
12	17
16	22
20	29

24	31
27	34
30	38
33	40
36	44
39	46

Testing of Pipe Line : After laying and jointing, pipe line must be pressure tested to ensure that pipe line joints are sound enough to withstand maximum pressure likely to be developed under working pressure likely to be developed under working conditions. The full test imposed should not be less than the following:

a) 1.5 times the maximum sustained operating pressure.
b) 1.5 times the maximum pipe line static pressure.
c) Sum of the maximum sustained operating pressure and the maximum surge pressure.
d) Sum of the pope line static pressure subject to a maximum equal to works test pressure forany pipe fitting incorporated.

The leakage should exceed 0.1 litres per mm of pipe dia per Km of pipeline per dayfor each 30 m head of pressure applied. When a pressure drop occurs, the quantityof water added in order to reestablish the test pressure should be carefully measured which amounts to leakage.

2.22 Measurement:

a. Excavation
b. Measurement for excavation of pipes trenches shall be made per linear meter.

c. Trenches shall be measurement between outside walls of manholes at top and the depth shall be the average depth between the two ends to the nearest cm. The rate quoted shall be for a depth upto 1.5 metre or as given in the Bill of Quantities.

d. Payment for trenches more than 1.5 m in depth shall be made for extra depth as given in theBill of Quantities and above the rate for depth upto 1.5 m.

e. CI class (LA) pipes shall be measured for the length of the pipe line per linear meter i.e.:

i. Length between manholes shall be recorded from inside of one manhole or inside of other manhole.
ii. Length between gully trap and manhole shall be recorded between socket of pipenear gully trap and inside of manhole.

2.23 Salt Glazed Stoneware Pipes

Stoneware pipes shall be new and of First Class quality salt glazed and free from rough texture inside and outside and straight. All pipes shall comply with BIS:651 and have the manufacturersname marked on them.

2.23.1 Laying of Salt Glazed Stoneware Pipes:

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

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

Where pipes are not bedded on concrete the trench bottom shall be left slightly high and carefully bottomed up as pipes laying proceeds so that the pipe barrels rest on firm ground. If excavation has been carried to low it shall be made up with cement concrete 1:4:8 (1 cement : 4 coarse sand : 8 stone aggregate 20 mm nominal size) at the Contractor's cost and charges

2.23.2 Jointing of Salt Glazed Stoneware Pipes:

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

The remainder of the socket shall be filled with stiff mix of cement mortar (1 cement: 1 clear sharp washed sand). When the socket is filled, a fillet shall be of 45 degrees with the barrel of that pipe. The mortar shall be mixed as needed for immediate use and no mortar shall be beatenup and used after it has begun to set.

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

2.23.3 S.W. Gully Trap

Gully trap shall be stoneware conforming to BIS:651. These shall be sound and free from visibledefects such as fire cracks, or hair cracks. The glaze of the traps shall be free from cracks. Theyshall give a sharp clear note when struck with light hammer. There shall be no broken blisters. Each gully trap shall have one CI grating of square size corresponding to the.dimensions of inletof gully trap. It will also have a water tight CI cover with frame inside dimensions 300 x 300 mm

the cover weighing not less than 4.5 kg and the frame not less than 2.7 kg. The grating cover and frame shall be of good casting and shall have truly square machined seating faces.

2.23.4 Fixing of S.W. Gully Trap

The excavation for gully traps shall be done true to dimensions and levels as indicated on plansor as directed by the Project Manager /Consultant / Architect. The gully traps shall be fixed on cement concrete foundation 65 cm square and not less than 10 cm thick. The mix for the concrete will be 1:4:8. The jointing of gully outlet to the branch drain shall be done similar to the jointing of S.W. Pipes described earlier. After fixing and testing gully and branch drain, a brick work of specified class in cement mortar 1:5 shall be built with a half brick masonry work round the gully trap from the top of the bed concrete upto ground level. The space between the chamber and trap shall be filled in with cement concrete 1:3:6. The upper portion of the chamber
i.e. above the top level of the trap shall be plastered inside the cement mortar 1:3 finish with a floating coat of neat cement. The corners and bottom of the chamber shall be rounded off so asto slope towards the grating.

CI cover with frame 300 x 300 mm (inside) shall then be fixed on the top of the brick masonry with cement concrete 1:2:4 and rendered smooth. The finished top cover shall be so as to prevent the surface water from entering the gully trap.

2.23.5 Measurements

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

2.24 Unplasticized Non-Pressure Polyvinyl Chloride (Pvc-U)

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2.24.1 Composition of the Material

The material from which the pipe is produced shall consist substantially of polyvinyl chloride, to which may be added only those additives that are needed to facilitate the manufacture of the compound and the manufacture of sound and durable pipe of good surface finish, mechanical strength and opacity under conditions of use. None of these additives shall be used separately or together in quantities sufficient materially to impair the fabrication or welding properties of thepipe, or to impair its chemical and physical or mechanical properties (in particular long-term mechanical strength and impact strength) as defined in this standard.

The material shall contain a minimum of 0.3 percent of rutile grade titanium dioxide.

When sealing rings are retained by means of retaining devices (rings or caps), the devices maybe made from polymers other than PVC-U, provided they conform to the same functional dimensions and test requirements as applied to sockets with either loose or fixed sealing rings.

2.24.2 Dimensions

Dimension or Pipes Mean outside Diameter

The mean outside diameter, outside diameter at any point and tolerances shall be as given in Table 1 and shall be measured according to the method given in IS 12235(Part 1).

Table 1 Outside Diameters and Tolerances(Clause 6.1.1)
All dimensions in millimeters

Sl. No.	Nominal Outside diameter, da	Mean Outside Diameter, dem		Outside Diameter at Any Point, de	
		Min	Max	Min	Max
(1)	(2)	(3)	(4)	(5)	(6)
i)	110	110.0	110.4	108.6	111.4
ii)	125	125.0	125.4	123.5	126.5
iii)	160	160.0	160.5	158.0	162.0
iv)	200	200.0	200.6	197.6	202.4
v)	250	250.0	250.8	247.0	253.0
vi)	315	315.0	316.0	311.2	318.8
vii)	400	400.0	401.2	295.2	404.8
viii)	500	500.0	501.5	494.0	506.0
ix)	630	630.0	631.9	622.4	637.6

2.24.3 Length of Pipe

The lengths may be supplied as agreed to between the purchaser and the manufacturer.

2.24.4 Dimensions of Integral Sockets and Spigots Ends

The basic dimensions shall be in accordance with Tables 3 and 4, and Fig. 2, 3, 4 and 5.

2.24.5 Wall Thickness of Sockets

e2min =0.9e and e3 min = 0.75e

e3 min applies only to those parts of the sealing ring zone where the fluid contained within the pipe comes into contact with the fluid, that is beyond the designated ring seal point, walls thinner than e3 are permitted.

If retaining caps or rings are- provided, they can be made to other designs or from polymers other than unplasticized polyvinyl chloride, provided that the finished joint conforms to the samefunctional test requirements.

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When a sealing ring is retained by means of a retaining ring or cap, the wall thickness of the area shall be calculated by addition of the wall thickness at the corresponding places of the socket and the retaining ring or cap (see Fig. 3). In all cases, the components shall meet the functional test requirements.

Table 3 Dimensions of Elastomeric Sealing Ring Sockets and Spigot Ends(Clause 6.1.4)
All dimensions in millimeters

Sl. No.	Nominal diameter, dn	Socket			Spigot End	
		dsm	A	C	l1	H1
		Min	Min	Max	Min	
(1)	(2)	(3)	(4)	(5)	(6)	(7)
i)	110	110.4	32	26	60	6
ii)	125	125.4	35	26	67	6
iii)	160	160.5	42	32	81	7
iv)	200	200.6	50	40	99	9
v)	250	250.8	55	70	125	9
vi)	315	316.0	62	70	132	12
vii)	400	401.2	70	80	150	15
viii)	500	501.5	80	--	160	18
ix)	630	631.9	93	--	188	23

NOTES

1. A MIN for dn ≤ 200 mm, shall be 0.2 dn + 10 mm

2. A MIN for dn ≤ 250 mm, shall be 0.1 dn + 30 mm

3. Values for B may be smaller for constructions with sealing rings firmly fixed in the groove of the socket. Where sealing rings are firmly and have multiple sealing zones, the dimensions Amin and C max should be measured to the effective sealing point as specified by the manufacturer (see Fig.4)

Table 4 Dimensions of Sockets and Spigot Ends for Solvent - Cemented Joints(Clause 6.1.4)
All dimensions in millimeters

Sl. No.	Nominal diameter, dn	Socket			Spigot End	
		dsm	A	C	l1	H1
		Min	Min	Max	Min	
(1)	(2)	(3)	(4)	(5)	(6)	(7)
		Min	Min	Max	Min	

(1)	(2)	(3)	(4)	(5)	(6)	(7)
i)	110	110.1	110.4	61.0	67	6
ii)	125	125.1	125.4	68.5	78	6
iii)	160	160.2	160.4	86.0	100	7
iv)	200	200.3	200.6	106.0	134	9

NOTES

For solvent cement sockets, the manufacturer shall declare whether the socket isdesigned tapered or parallel. If they are parallel, or near parallel, the mean outsidediameter of the socket, dsm shall apply over the entire length of the socket. If the socket is tapered, then the limits for dsm apply at the mid point of the socket with a maximum taper of 0° 30.

2.24.6 Physical Characteristics

Appearance

When viewed without magnification, the internal and external surfaces of the pipe shall be smooth, clean and tree from grooving, blistering and any other surface irregularity, which is likely to prevent conformance of the pipe with this standard. Slight shallow longitudinal grooves or irregularities in the pipe shall be permissible, provided the wall thickness remains within permissible limits. The pipe wall shall not contain impurities or pores. The pipe ends shall be cleanly cut and reasonably square to the axis of the pipe.

Colour

The colour of the pipes shall be dark (any shade of brown). The pipe shall be uniformly colouredthroughout the entire wall. Slight variations in the appearance of the colour are permitted.

2.24.7 Mechanical Characteristics

Resistance to External Blows at 0°C

When tested according to the method prescribed in Annex B, the pipe shall have a true impact rate of not more than I percent. In case of socket-ended pipes, this test shall be carried out on the plain portion of the pipe taken at least 100 mm away from the root of the socket.

Ring Stiffness

When tested according to the method described in Annex C, the ring stiffness of the pipe shall be as stated in Table 5.

Table 5 Ring Stiffness of Pipes(Clause 8.2)
All dimensions in millimeters

Sl. No.	SDR / Stiffness Class	Ring Stiffness
		kN.m-2
(1)	(2)	(3)
i)	51/SN 2	≤ 2
ii)	41/SN 4	≤ 4
iii)	34/SN 8	≤ 8

Resistance to Internal Hydrostatic Pressure (Type Test)

When tested according to the method described in IS 12235 (Part 8) the pipe shall not fail (seep,crack, bulge or burst) during the prescribed test duration of the test and shall meet therequirements given in Table 6.

Table 6 Requirement of Pipes for Internal Hydrostatic Pressure Test(Clause 8.3)

Sl. No.	Test	Test Temperature	Test Duration
		°C	(Minimum Holding Time)
(1)	(2)	(3)	(4)
i)	Acceptance test	27	1
ii)	Type test	60	1000

2.24.8 Joints

Elastomeric Sealing Rings

Elastomeric sealing rings shall be free from substances (for example, plasticizers) that can havea detrimental effect on the polyvinyl chloride of the pipes or fittings used in conjunction with the pipes.

The design of the profile and dimensions of the sealing ring is left to the manufacturer, as long as the pipe with the sealing ring meets the requirements of this standard. Where the design of the socket is such that the sealing ring is not firmly fixed in position, the housing for the ring shall

be so designed as to minimize the possibility of the ring being dislodged during insertion of the pipe (or spigot of a fitting) to complete the joint.

Elastomeric sealing rings shall be in accordance with one of the types (Type 1 to Type 6) of IS 5382. The manufacturer has to, however, specify the type of sealing ring (namely Type 1, 2, 3, 4, 5 or 6) that is being offered.

Solvent Cement

The solvent cement used shall conform to the requirements laid down in IS 14182.

2.24.9 Performance Requirements

Elastomeric Sealing Ring Joints

Internal Hydrostatic Pressure

When tested according to the method described in Annex D, the joint, when assembled according to the manufacturer's instructions and subjected to an angular deflection,α, of minimum 2°as well as a diametric deflection (distortion) of 5 percent of the outer diameter, shall withstand an internal pressure of up to and including 0.05 MPa (0.5 bar) fora minimum of 15 minwithout leakage.

Internal Negative Hydrostatic Pressure (Internal Vacuum)

When tested according to the method described in Annex E, the joint, when assembled according to the manufacturer's instructions and subjected to an angular deflection,α, of minimum 2° as well as a diametric deflection (distortion) of 5 percent of the outer diameter, shallwithstand an internal negative pressure (internal vacuum) of up to and including 0.03 MPa (0.3 bar) for a minimum of 15 min without leakage.

Solvent Cemented Joints

Internal Hydrostatic Pressure

When assembled according to the manufacturer's instructions, the joint shall withstand an internal pressure of up to and including 0.05 MPa (0.5 bar) - for a minimum period of 15 min without leakage.

Internal Negative Hydrostatic Pressure (Internal Vacuum)

When assembled according to the manufacturer's instructions, the joint shall withstand an internal negative pressure (internal vacuum) of up to and including 0.03 MPa (0.3 bar) for a minimum period of 15 min without leakage.

2.24.10 Marking

Each pipe shall be clearly and indelibly marked in ink / paint or hot embossed on white base at intervals of not more than 3 m, but at least once per pipe, in the colour indicated in 12.3. The marking shall be legible without magnification. The marking shall not initiate cracks or other types of defects which adversely influence the performance of the pipe. Marking by indentation reducing the wall thickness not more than 0.15 mm shall be deemed to conform to this clause without infringing the requirements for the wall thickness given in 2.1.2.

The marking shall show the following:

i. Identification of the source of manufacture,
ii. Outside diameter, -
iii. Stiffness class, and
iv. Batch or Lot number.

The colour of the marking shall be such that it differs from the basic colour of the pipe.

BIS Certification Marking

Each pipe may also be marked with the ISI Standard Mark.

The use of the Standard Mark is governed by the provisions of the Bureau of Indian Standards Act, 1986 and the rules and regulations made thereunder. Details of conditions under which a license for the use of the Standard Mark may be granted to the manufacturers or the producers may be obtained from the Bureau of Indian Standards.

Table 6 Requirement of Pipes for Internal Hydrostatic Pressure Test(Clause 8.3)

Sl. No.	Test	Test Temperature	Test Duration
		°C	(Minimum Holding Time)
(1)	(2)	(3)	(4)
i)	Acceptance test	27	1
ii)	Type test	60	1000

2.24.11 Construction of Manhole

Where manholes are to be constructed, the excavation, filling back and ramming, disposal of surplus earth, preparation of bottom and sides etc. shall be carried out as described earlier under trench excavation. Manhole shall be sized and depths as called for in the drawings and Bill of Quantities.

The manhole shall be built on a base concrete 1:3:6 of 150 mm thickness for manholes

upto 1500 mm depth and 250 mm thickness for manholes from 1500 to 2500 mm depth and 300 mmthickness manholes of depth greater than 2500 mm. Reinforcement as shown shall be providedin the base slabs.

The walls shall be of brick work of thickness as shown in drawings built in cement mortar 1:5. The joints of brick work shall be raked and plastered internally in cement mortar 1:3 (at least 12 mm thick) and finish with a coat of neat cement, external plaster shall be rough plaster in 1:3, PCC benching & semicircular channels of the same diameter as the pipes shall be provided and finished with neat cement coating.

Above the horizontal diameter, the sides of channel shall be extended vertically to the same level as the crown of the outgoing pipe and the top edge shall be suitably rounded off. The branch channels shall also be similarly constructed with respect to the benching but at their junction with the main channel an appropriate fall suitably rounded off in the direction of flow in the main channel shall be given. All manholes / sumps shall be provided with poly propylene coated steel reinforced foot rest. The polypropylene shall confirm to ASTM D-4101 specification, injection moulded around 12 mm dia IS-1786 grade FE-415 steel reinforcing bar. These rungs shall be set at 30 cms interval in two vertical runs at 380 mm apart horizontally. The top rung shall be 450 mm below the manhole cover. Unless otherwise mentioned, manholes shall be constructed to the requirements of Indian Standard BIS:4111 (Part I). All manholes shall be constructed so as to be water tight under test. All angles shall be rounded to a 75 mm radius with cement plaster 20 mm thick. The benching at the side shall be carried out in such a mannerso as to provide no lodgment for any splashing in case of accidental flooding. Manhole cover with frame shall be of cast iron of an approved make. The covers and frame shall generally be double seal as specified in the Bill of Quantities.

Measurements

Manhole shall be measured in numbers as indicated in the Bill of Quantity. The depth of manhole shall be measured from invert of channel to the top of manhole cover.

Manhole with depth greater than specified under the main item shall be paid for under 'Extra Depth' and shall include all items as given for manholes depth will be measured to the nearest cm. Depth of the manholes shall be measured from top of the manhole cover to bottom of channel. The following are inclusive in the cost of manhole viz;

i. Bed concrete
ii. Brick work.
iii. Plastering (inside & outside)
iv. RCC top slab, benching and channeling including drop connections.
v. Supply and fix foot rests.
vi. Keeping holes and embedding pipes for all the connections.
vii. Excavation, refilling, necessary de-watering and disposing off surplus soil to a places as directed by Project Manager.
viii. Curing.
ix. Cost of angle frame and embedding the frame in concrete bed.

x. Testing.
xi. De-watering of chambers.

Drop Connection

Drop connection shall be provided between branch sewer and main sewer in the main sewer itself in steep ground when the difference in invert level of two exceeds 60 cms of the required sizes. Drop connections from gully traps to main sewer in rectangular shall be made inside the manholes and shall have CI special types door bend on to top and heel rest bend at bottom connected by a CI pipe. The pipe shall be supported by holder bat clamps at 180 cms intervals with atleast one clamp for each drop connection. All joints shall be lead caulked joints 25 mm deep.

Drop connections from branch sewer to main sewer shall be made outside the manhole wall withCI / CI class LA pipe, connection, vertical pipe and bend at the bottoms. The top of the tee shallbe finished upto the surface level and provided with a CI hinges type frame and cover 30 cms x 30 cms. The connection and tee upto the surface chamber of the tee.

Drop connection made from vertical stacks directly into manholes shall not be considered as drop connections.

Road Gully chambers

The chamber shall be of brick masonry with Bricks of class designation 75 in cement mortar 1:5(1 cement : 5 coarse sand) and shall have a PCC/SFRC/DI gully grating with frame fixed in 150 mm thick cement concrete 1: 2 :4 (1 cement : 2 coarse sand : 4 hard stone ballast 20 mm nominal size) on top. The size of the chamber shall be taken as the clear internal dimension as specified in the schedule of quantities. The brick walls on the top of the bed concrete 1:4:8 (1 cement : 4 coarse sand :8 hard stone ballast 40 mm and down gauge) of the chamber shall be plastered with 12 mm thick cement plaster 1:3 (1 cement : 3 coarse sand) internally and externally and finished with a floating coat of neat cement . The excavation shall be done true todimension and level shown in the drawing.

Masonry Drains

Brick masonry drains shall be of a minimum width of 30 cms for depth upto 45 cm and a maximum width of drains shall be 45 cms for depths beyond 45 cms. However, in special caseswhere the depth is very high, the width of drain shall be in proportion of 1:5 with the depth. Brickmasonry drains shall be constructed in brick masonry in cement mortar 1:5 in cement concrete foundations as specified in the schedule of quantities. Wherever specified, masonry drains shallbe plastered with cement mortar inside. The outer surface shall be flush pointed withoutadditional charge.

All brick masonry covered drains shall be provided with Cast Iron perforated cover with frame orcast in situ or precast RCC slabs as specified in drawings. All drains shall be plastered with cement mortar 1:4, 12 mm thick with a coat of neat cement. All finished work shall afford specified gradient to ensure free and efficient discharge.

Payment for masonry drains shall be made under individual items of masonry, cement concrete and plaster by volume of area as given in the drawings and schedule of quantities.

Making Connections

Contractor shall connect the new sewer line to the existing manhole by cutting the walls benching and restoring them to the original condition. A new channel shall be cut in the benching of the existing manhole for the new connection. Contractor shall remove all sewage and water if encountered in making the connection without additional cost.

2.25 Transfer Pumps for Water Supply and Drainage System

2.25.1 Scope

- This section of the contract involves the design, supply, installation, testing and commissioning of the complete Water Transfer pumping system and other pumping systemscomplete with all controls and electrical work for domestic water supply, water supply for flushing. All submersible water re-circulation, drainage and ejector pumps for the project arealso included in this contract. It also involves testing and commissioning of the pumping system with the domestic water and flushing water supply & distribution.

- This specification described the particulars of the contract, designs and systems chosen, and mode of operation.

- All installation work shall comply with the latest rules and regulations.

- The work embraced by this specification covers the design, submission to authorities, supply, and delivery on site, installation, testing, commissioning and maintenance of the Water Transfer pumping system, other pumping system installation of the building in accordance with this specification and associated drawings.

- The scope of work shall include the following (list is indicative and not exhaustive) :

- Pumping units domestic water & flushing water supply & distribution.

- Suitably sized food grade quality, non-toxic diaphragm type pressure vessels complete withnecessary interconnections and controls.

- Control panel for pump control complete with variable speed drives, circuit breakers, fusses,pressure transmitters etc. complete with all interconnections to pumps and electrical supply panels.

- Pump control units complete with pre-programmed micro-processor chip.

- Pump monitoring units to monitor operation of pumps.

- Submersible water re-circulation pump for water fountain, drainage pumps for plant room drainage complete with electrical panels and necessary accessories with automation for pump operation.

- All the pipework etc. shown in the system drawings is meant for information only and shall be carried out by others. The Water Transfer system supplier shall provide the pumping units in the designated pump rooms as complete units included all necessary piping within plant such that only discharge connections are required to be connected into the unit's discharge manifolds just inside the plant room, by the Plumbing contractor. The Water Transfer system contractor shall guarantee specified pump performance at various pump speeds and Water Transfer pumps must be able to supply at least 2 bar pressure at the highest/farthest fitting.

- Electrical equipment and installation work including the PLC in Control panel.
- Painting and labelling of pipe work and equipment;
- Provision of all hold down bolts, spigots struts and the like required to be built in duringconstruction;
- Provision of dry contacts to BMS indicating the status of the pumps and pressure vessel inform of hardware interfacing panels inside each pump room and control panels of all pumps.
- Provision of all level switches, flow switches and other sensing devices for status indication.
- All interfacing work with other trades.
- Testing & commissioning and balancing of the Water Transfer & Pumping system;
- Provision of twenty four (24) months operational maintenance and breakdown services;
- Provisions of operating instructions and maintenance manuals;
- Provision of spare parts;
- Training of the employer's staff for proper operation of the entire systems;
- Liaison with Local Authorities to obtain all necessary certificates and approvals, including thecompletion of all submission drawings, forms and payment of any fees and charges. All the costs for all the tests required by Local Authorities shall be included. To attend to any Authorities inspection regardless of whether this inspection is carried out after the defect liability period;
- Provisions of the necessary installation which include pumping works, pipe work within the pumping unit up to suction and discharge manifolds, conduit and control wiring, etc. to form a workable system required;
- All other works and systems as specified in the Contract document and or shown on the drawings.
- All cutting, patching, framing up, furring in, chasing and making good associated with the building construction for the passage of pipes, conduits and the like including providing GI pipes sleeves of required size corresponding to pipe dia, wherever pipes crossing fire rated walls and floors and sealing with glass wool in between and fire sealant compound on eitherend. Details on shop drawings shall also be provided.

Note: The system shall be supplied through the OEM with the above as a complete skid mounted packaged unit.

2.25.2 General

Equipment offered for supply and installation shall include the following:

All minor items and incidental work, equipment accessories and materials may not be specifically mentioned but are required for the proper completion of the installations in accordance with the true intent and meaning of this Specification.

All necessary safety devices for the protection of personnel against injury and the protection of plant and equipment against damage including relief valves, belt guards, fan inlet and/or discharge guards, safety railing, effective earthing of electrical components, electrical interlocks,warning lights and alarms.

Readily accessible, dust-proof lubricating facilities on all moving parts and equipment including provision for cleaning all lubricating lines and bearings and charging same with the correct lubricants after installation but prior to testing and commissioning.

Clearly visible and robust manufacturer's name-plates permanently fitted each and every item ofequipment and showing the manufacturer's name, type and/or model number, serial number, and all essential operating data such as speed, capacity, voltage, current draw, etc.

The Contractor also shall allow provision for the inspection of all plant and equipment by the manufacturer or his licensed representative, at least twice during the course of the installation.

2.25.3 Piping

The pipes and fittings in the domestic Water Treatment plant room shall be GI class `C' (heavy class) conforming to BIS: 1239 (Part-I) for pipes and BIS:1879 (Part 1 to 10) for malleable cast iron galvanized fittings.

All drainage / buried piping shall be cast iron pipes (CI Class LA) as per BIS:1536 and fittings with ty-ton joints complete with required accessories (Fittings shall be of lead joints).

2.25.4 Pumps for water Transfer & Drainage System

Pumps

Pumps shall be vertical, centrifugal, multistage directly coupled to motor. Provision of pump withpump head & base of cast iron and other parts in SS 304 shall be made for pumps required in Water Transfer System and water fountain re-circulation system. Impeller shall be hydraulically balanced and keyed to shaft. Pump shall be mounted on a concrete foundation, projecting at least 15 CM above finished floor level. The pumps base shall be set on a vibration elimination pad. The pump shall be lubricated in strict accordance with the manufacturer's instructions and shall be factory aligned prior to shipment. All motors and bases shall be painted with approved finish shop coat of paint.

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The pump shall be selected for the lowest operating noise level and shall be complete with flexible connections, valves, and pressure gauges. The pumps shall include cost of foundation channel complete. The pumping system shall be supplied as completesets including suction and discharge common manifolds, non-return valves, isolating valves, pressure transmitter on the discharge side and electrode at the suction tank.

The Contractor shall supply and install pumps of the type and performance as shown on the drawings. All duties of pumps given in the Tender Drawings shall be checked and where necessary corrected before ordering. All the parts of the pumps that are in contact with water
e.g. shaft, impeller etc. shall be of stainless steel construction.

Pumps shall be so selected that the design duty point is within 5% of the maximum efficiency point. The pump casing so selected shall have ample space to take an impeller one size larger than that capable of performing the design duty.

The pump shall have a speed of not more than 1500 rpm. However pumps of 2900 rpm with high efficiency and low noise motor can be selected and noise data submitted for approval. All pumps and motors shall be of minimum vibration and noise level during operation. Vibration isolators shall be provided for all pump sets.

Facilities shall be provided to prevent starting of pumps when the water tank is at low water level. An indicator for this low water level alarm shall be provided.

Facilities to select which pump to be duty pump and standby pump shall be provided and be interchangeable.

Leakage from pump gland shall be drained to the nearest floor waste.

Pump curves for all pumps offered shall be submitted. All curve indicating excessive shut-off head will not be approved.

Each pump shall be provided with a gate valve at suction and discharge, approved check valve at discharge, approved strainer at suction, flexible connections at pump suction and discharge, eccentric reducer at suction, concentric reducer at discharge, pressure gauges at suction and discharge, circulation relief valve and automatic air relief valve.

Appropriate neoprene vibration isolation mountings shall be provided for each pump sets.

Vertical Multi-Stage Pumps

Multi-stage pumps shall be of centrifugal type and arranged with shafts vertically installed. The impellers shall be of stainless steel mechanically balanced and keyed to shaft. Renewable guiderings are to be provided in the casting, keyed to prevent rotation.

Pumps shall be driven by elevated in-line TEFC squirrel cage motors via extended vertical shafted complete with universal couplings.

The shafts shall be stainless steel. Stainless steel sleeves shall be provided to protect the shaft in the water space and through the sealing glands. The sleeves shall be keyed to prevent rotation and secured against axial movement.

The bearings shall be of ball or roller type protected against ingress of water, dirt and other matter.

Vertical multistage pumps shall have universal flanges. Intermediate bearing, support bearing shall be provided in the pump.

The shaft seal shall be easily serviceable and shall allow for correct adjustment and loading of the seal. Pump motors above 7.5 kW shall be equipped with a spacer coupling which allows changing of shaft seals without removing the motor. The pump motors shall be of Class "F" insulation and IP55 rating and shall be provided with built-in thermistors for protection against over heating.

Variable Speed Water Transfer Pumping System

Variable speed Water Transfer pumping units shall be provided for supply of domestic water, flushing water supply for the project. The units shall be selected so as to provide at minimum of 2 bar pressure at the highest/farthest fitting in each plumbing system, the unit serves. The pumping units shall have the following features ;

System Description

The system shall be supplied as complete sets including suction and discharge common manifolds, non-return valves, isolating valves, pressure transmitter on the discharge side and electrode at the suction tank.

The system operation will be such that the initial small water demand shall be met by the charged diaphragm pressure vessel. Should the water demand continue the system pressure will dip to a preset pump cut-in point when the lead pump starts to operate at reduced speed through the variable speed drive However, should the system pressure be still below the presetvalue, the controller continuously increases pump speed to meet the system demand. When thelead pump is not able to meet the system pressure at full speed, the second pump also starts tooperate.

At peak demand all the pumps operate, similarly, if there is a drop in water demand the duty pump speed starts to reduce, then standby pumps cuts-off, followed by stopping of the duty pump.

The closed diaphragm pressure vessel shall be of polyethylene material with a pressure gauge and isolating valve. The interior shall be of non-toxic lining suitable for use with potable water. The vessel shall be manufactured to conform to ASME pressure vessel code/standards.

The system shall be under the control of an electronic microprocessor unit (EMU).

A pressure transmitter shall detect the pressure at the delivery manifold and feedback to the microprocessor control panel via control circuit.

The system shall incorporate a frequency converter or frequency converter motors on the pumps and the pressure transmitter shall register the actual pressure on the discharge side.

The variable speed drive pumping system shall maintain a constant pressure regardless of the system demand. If there is a drop in pressure outside the preset point, the Variable Speed Drive(VSD) pump shall start to run until the pressure increases to the preset limit, or it will continue toincrease the pump speeds to the upper limit of the frequency. If the water system demand still cannot be met, the second pump shall be called in to run, the VSD will then alter the pump speed to meet the preset pressure point. If the set point is still unable to be met, the third pump is then activated to run (in case of 3 pumps units).

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This shall be achieved by continuously varying the motor speed of the duty pump according to the demand up to a maximum designed capacity.

Under decreasing hydraulic demand the reverse sequence to the above description shall apply.

The EMU shall ensure alternation of all the duty and standby pumps for even running hours for all the pumps.

The frequency converter shall be linked to the motor of the duty pump for continuous speed adjustment and ultimately the water delivery shall be maintained at constant pressure at the preset value.

Local Motor Control Panel

The motor control panel shall be equipped with all the necessary electrical components includinga microprocessor control unit and a frequency drive. The control panel and the microprocessor shall cover the followings functions:

- Flexibility and simplicity in allowing the necessary re-adjustment of the pumping system pre-set delivery pressure to operate the pumps within the specified maximum and minimum delivery ranges.
- Built-in frictional loss compensation factor which will automatically increase the delivery pressure setting, in collaboration with the increase in flow demand. This shall be able to minimize the system pressure differences and provide a more constant pressure along the supply line and also to save the energy consumption of the motor when running at low speed.
- Automatic changeover of the pumps to be controlled by the microprocessor which dictates the duty and standby pumps to run at variable speed.
- Built-in clock functions with weekly programming and with switch on system to operate at least 10 different pre-set pressure points as required.
- When the system has not been operated for more than 24 hours, it shall automatically start the pumps for a few seconds/day to ensure the pumps readiness at all times. The standby pumps shall be activated upon failure of duty pump(s). In event of control failure, the pumpsshall be able to be start/stopped manually at the local panel by means of pressure switches.
- The microprocessor control panel shall be able to cut-off the pumping system when excess pressure is registered in the discharge common manifold.
- The system shall have the capability of receiving input signal concerning reduced water levelin suction tanks and shall have control mechanisms to prevent the pumps form running dry.

  Automatically starting the pumps when the water level is back to normal.
- In case of pump failure due to motor overload, the standby pump is switched on automatically. Alarm signal is displayed on the LCD Display unit and alarm lights are activated.

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- Functions to limit the no. of start/stop of pumps per hour.

- The system control panel shall incorporate at least the following components :

  a. LCD Display
  b. Pumps selections for up to 4 pumps so that system controller can control up to 6pumps
  c. Pump status button to display duty pump speed and system capacity
  d. Zone status button to display operating parameters for different pumping units
  e. Setting button to input preset pressure, system start/stop time etc.
  f. ±1 button to key in numeric data such as pressure set point, etc.
  g. Enter button for confirmation of input into the system
  h. Alarm button to show location of fault - self diagnostic function display
  i. Hour Run measurement for each supplied pump set
  j. Buttons for scrolling to select the actual display reading for system configuration, i.e.up and down scroll concept.
  k. Necessary devices for programming, supervising and monitoring operation data/system, status shall be incorporating into the control panel.

Operations

Local control panel shall perform as follows :

Auto mode

The desired delivery pressure within the range specified shall be set at the duty local control panel. The pressure transmitter shall detect the delivery pressure continuously within 1 second and feedback to the microprocessor which will control the variable speed drive frequency converter for speed control of the duty pump. When demand increases, the subsequent pumps in the system will be activated to boost up the pressure. Ultimately the duty pump set shall be operated fully automatically to maintain the delivery pressure constantly at the desired set value.

Manual Mode

The on/off function of the pumps shall be manually adjusted at the microprocessor located at thelocal control panel.

Frequency Control By-pass Mode

All the pump sets shall be started/stopped automatically with the pump output at fixed maximumrotational speed. All the control and protection functions shall remain active. The cut in/cut out pressure shall be internally calculated by the microprocessor for each pump.

System Features

The required performance features of each Water Transfer pumping unit shall be as follows :

System Configuration

Variable speed pumps with pressure vessels.

Control panel consisting of the following components :

- Pump Functional Unit (PFU) - control unit c/w pre-programmed microprocessor chip. Thisunit shall control all pumping unit operations through electronic controller.
- Pumping Monitoring Unit (PMU) - monitor the operation of the pump sets. This unit shallallow for monitoring and setting of all control parameter.
- Variable Speed Drive
- Circuit Breakers
- Fusses
- Pressure Transmitter

Set Point

Ten separate pressure "set points" shall be able to be programmed into the PMU and switching between set points is timed by a real time clock when a lower pressure is acceptable during certain periods, for instance after hours or weekends, the set point shall be lowered to minimize power consumption.

An external input shall also be used to switch between set points, or manually adjust a set pointat any time.

Friction Loss Compensation

It shall be possible to allow for the friction loss component of the system, calculated at full flow and set as a percentage of the set point which will reduce the working pressure of the pump set depending on the actual no. of pumps in operation. A linear approximation of system resistancecurve can therefore be allowed for, and pressure will automatically increase as system flow andsubsequent frictional losses increase. As such power consumption shall reduce which is required for the pumping system.

Displays

Through the PMU keypad all variable parameters shall be adjustable, current status of settingsand measured values shall be able to display on the 2 line x 24 character liquid crystal display.

Individual menus shall be available for monitoring individual pumps, zones, settings, alarms andON/OFF functions.

Pump Status

Running hours of each pump

Actual pump status (running, not available, standby, allocated to zone, fault) Maximum head of pump at zero flow.

Zone Status

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This menu shall be the main operating menu where at the setting and operating parameters canbe viewed,

- Current operating set point
- Measured values in the system
- Operating capacity in terms of total output
- Mode of operation for the zone
- Clock programs (relating to set point pressures)
- Standby pumps
- Pump change over time
- Zone configuration
- Pressure transducer scaling
- Friction loss compensation
- Pump priority
- Inlet pressure measuring (if required)
- System response times
- Allowable number of starts per hour for the pumps
- Minimum limit (loss of water, burst mains protection)

Setting Menu (Set)

In this menu all parameters for the operation of the pump set shall be able to be adjusted asrequired.

a Set points (up to 10)

b. On/Off function (used to prevent unnecessary cycling at low demands)

c. Displayed pressure units (Bar, PSI, mBar, kPa)

d. Real time clock programming for any time of the day, week, or weekend

e. Zone configuration

f. Friction loss compensation

Alarm

The alarm menu shall display all faults that occur during operation, logging the time and date of when the fault occurred and when it was corrected, or whether it is still an actual fault, up to 10 faults can be maintained as history in the controller. The following type of faults shall be diagnosed by the controller.

a. Mains failure

b. Frequency converter fault

c. Analogue input (pressure transducer) fault

d. High discharge pressure fault

e. Low discharge pressure fault

f. Motor thermal overload fault

Variable Frequency Drive

Variable frequency drive shall be of a reputable make acceptable to Project Manager and shallbe complete with RFI filter and harmonic dampers.

Enclosure

An IP 54 powder coated steel enclosure shall house all the electrical components.

The enclosure can be supplied loose for remote mounting, or mounted on a common base with the pumps, it shall be adequately ventilated for use in conditions up to a maximum ambient temperature of 45 degrees Celsius.

Electrical Component

All circuit breakers, thermal overloads and contactors shall be of reputable make acceptable to the architect. Electrical supply to the pump controller shall be protected using an isolating circuitbreaker.

Method of Starting

The panel shall be built to start the pumps in suitable starting modes, i.e. DOL., Star/Delta, orusing Soft Starters.

Quality and Testing

Manufacture of the pumps, plus design and assembly of the complete packaged Water Transferpumping system shall be factory assembled and the pump station shall be fully tested hydraulically and electrically prior to dispatch to site. Test reports etc. shall be submitted for review before dispatch.

Pump Pressure Vessel

Diaphragm type pressure vessels shall be provided as shown on the drawings. They shall be incorporated into the system so that during normal operation the pump shall not need to be startwithin 30 seconds of it switching off in order to prevent the pump hunting.

The pressure vessel shall be of adequate capacity to accommodate a considerable fluctuation inwater demand by the system with minimum start/ stop cycles of the pumps. The vessel shall be constructed of steel plate built to ASME Standards for Unfired Pressure Vessel. A rubber diaphragm shall be provided in the vessel for separating the water and pre-charge nitrogen. The pre-charge pressure shall be adjustable and charging port with non-return device shall be provided. The adjustable cut-in and cut-off pressure unit for the pumps shall be built-in at the vessel to suit the system.

Float less Type Level Switch In Water Tanks

The Contractor shall supply and install float less type switch probes in the water tanks as indicated below and shown on the drawings.

Raw Water Tanks at Basement

- High level alarm (over-flow); to be reviewed project
- Low level alarm; to project basis
- Low level cut-out for raw water pumps;
- Earthing probe.

Cooling Tower Make-up

- High level alarm (over-flow);
- Low level alarm;
- Low level cut-out for cooling tower makeup water supply pumps;
- Earthing probe.

Potable Water Tank at Basement Level

- High level alarm (over-flow);
- Low level alarm;
- Low water level cut-out for the domestic Water Transfer pumps;
- Earthing probe.

Each probe shall be of the correct length for the particular application and tank location. Electrodes shall be of polished stainless steel 20 mm OD. Electrode holders shall be weatherproof in all respect.

The earthing probes shall be connected and wired to the building earth systems of the building.

Each set of electrodes shall be installed inside a 230 mm diameter PVC pipe acting as a wave barrier.

The level switch set shall operate with a stepped down voltage at 24V maximum. Stepped downtransformers shall be provided for each set of control probes and shall be installed inside centralised control cubicles inside pump room.

Mechanical steel stuffing boxes shall be used. Control of Duty / Standby Pumps

Operation of the duty and standby pumps shall be carried out by the following method: a Automatically by means of pressure sensor (i.e. pressure switches);

a Manually by means of a local start/stop push buttons on pump local motor control paneland emergency stop switch.

The pressure switch shall be installed next to the manual release valve. When the pressure drops to the pre-determined level, a signal will be sent to the pump local motor control panel to start the pump.

Automatic controls shall be operated by electronic, float less type level switches. Pump Indicator

The following audible and visible indication shall be provided at the pump local control panels asapplicable:

a Red "overflow level" indicator with buzzer for the associated water tanks

b Amber "extra high water level" indicator for the associated water tank;

c Amber "high water level" indicator;

d Amber "low water level" indicator;

e Red "pump trip" indicator for each pump;

f Green "pump on" indicator for each pump;

g "Pump electrical supply healthy" indicator for each pump; Amber "remote/local" status indicator.

CI MH covers for Water Tanks

Manhole covers and frame for Water Tanks shall be of Cast Iron. These shall be embedded in cement concrete slabs / brick works as shown on drawings. These shall be of medium duty, the weight of the same shall be as mentioned in schedule of quantities.

PVC Foot rests for Water Tanks

Providing and fixing safely foot rest of required shape of minimum 6 mm thick plastic encapsulated as per IS 10910 on 12 mm dia steel bar as per IS 1786 having minimum cross section as 23 mm x 25m³ overall minimum length 263 mm and width as 165 mm with minimum 112 mm space between protruded legs having 2 mm tread on top surface by ribbing besides ecessary and adequate anchoring projection on tail length of 138 mm and suitable to withstand and bend test and chemical resistance test as per manufacturer specification.

Preferably footrest shall be fixed before concreting of walls for UG tank or fixed cement concrete1:2:4 mix with proper anchoring.

Sump Pump

Submersible

These shall be fully submersible with a fully submersible motor. The pumps shall be provided
with an automatic level controller and all interconnecting power and control cabling which shall cause the pumps to operate when the water level in the sump rises to a preset level and stop when the preset low level is reached.

Pumps for drainage shall be single stage, single entry.

Pump shall be C.I. casing and C.I. two vane open type with a dynamically balanced impeller connected to a common shaft of the motor. The vane for sewage pump will be open type, while for drainage pump, etc. it will be of semi open type. The MOC of the sump shall be in accordance to schedule of quantity.

Stuffing box shall be provided with mechanical seals.

Each pump shall be provided with a suitably rated induction motor suitable for 415 volts, 3 phase, 50 Hz A.C. power supply.

Each pump shall be provided with in built 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 unit. The delivery pipe shall be joined to the pump through a rubber diaphragm, and bend and guide pipe for easy installation.

Pump shall be provided with all accessories and devices necessary and required for the pump tomake it a complete working system.

Sump pump shall be complete with level controllers, power and control switch gear, Auto/off/Manual switches, pumps priority selections and control and power cabling upto motor and controller/probes etc. (Including earthing). Level control shall be such that one pump starts on required level, 2nd pump cuts in at high level and alarms is given at extra high level. All level controllers shall be provided with remote level indications.

Motor Design

The pump motor shall be a squirrel cage induction, housed in air filled water-tight enclosure. Oilfilled motors are not acceptable. The stator windings shall be Class "F" insulation (155 degree Cor 311 degree F) for general usage and class 'H' insulation (180 degree C or 317-8 grade 2) forsubmersible type.

The stator shall be heat shrunk fitted into the enclosure and shall not use bolts, pins or other fasteners that penetrate through the stator enclosure. The starter shall be equipped with a thermal switch embedded in series in the coils of the stator windings to protect the stator from wheel.

The motors shall be designed for continuous running duty type at 415 volts, 3 phase, 50 Hz power supply and capable of sustaining a minimum of 20 starts/stops per hour.

Between stator housing and pump, a tandem seal arrangement will be provided with an oil barrier. Both seals run in oil, allowing dry running without seal damage. Both seals shall be of the rubber bellows or metallic bellow type with positive drive between shaft and rotating seal face

2.26 Commissioning, Testing & Balancing

2.26.1 General

All the commissioning, testing and balancing details as described herein and required by the Project Manager shall be deemed to be included in the contract value, nothing extra is payable on account of works / items executed on account of commissioning, testing and balancing of thesystem.

a) Commissioning of equipment shall be carried out by the Contractor in conjunction with representative of the manufactures or supplier of the specialist equipment included in this Contract. Co-ordinate commissioning with other trades.

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b) The Contractor's commissioning personnel must be experienced and trained. Qualification of the commissioning engineer to be submitted for Project Manager approval.

c) Testing on the entire installation to be fully carried out in parts or as a whole to demonstrate that the Contract work has been set to work in accordance with requirements of the specification.

d) All instruments, plant, supervision and labour required for equipment and system commissioning shall be provided by the Contractor. Instruments shall be accurately calibrated to the satisfaction of the Project Manager, prior to commissioning.

e) Record all commissioning results on record sheets. Submit testing procedures and test record format to the Project Manager for approval. On completion of commissioning and prior to Final Inspections and Handover, submit the commissioning results in a bound volume to the Project Manager, who reserves the right to witness such commissioning operations and procedures as necessary. Retention Money shall not be released until receipt of the Commissioning Record Manual.

f) Tests shall be carried out in accordance with the Employer's Insurance Company requirements where applicable, the appropriate British Standard and local authority requirement and codes of practice.

g) All tests shall be witnessed by the Project Manager and, in the case of routine/type tests at the manufacturer's works, by the Insurers. Contractor shall give adequate notice (14 days minimum) for this purpose.

h) All tests shall be properly certified in a format approved by the Project Manager and test certificates shall be submitted in triplicate to the Project Manager on completion of satisfactory tests.

i) The Contractor shall include in his tender all costs associated with all the commissioning and testing procedures specified, including the costs of making good and defects arising outof tests and having the works re-tested as necessary. Such cost shall include also provisionof all commissioning and testing instruments, test points, and fuel supply.

2.26.2 Test Certificates and Commissioning Records

a) The Contractor shall allow for submitting three copies of test certificates to the Project Manager bearing the signatures of the Contractor's and the Project Manager representativesat the test.

b) Test certificates shall serve as a certified record that the item referred to has been shown under test to meet the requirements of this document, Local Authority Regulations, International Standards and the like, where applicable.

c) Test certificates shall be dated, numbered and clearly referenced to the item tested by means of serial, chassis, or other manufacturers' reference number permanently marked in a conspicuous manner on the item concerned.

d) The Contractor shall submit to the Project Manager a complete set of data on all

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equipmentand systems which he commissions. The submittals shall be on A3 or A4 size paper and theform which they take shall be agreed with the Project Manager before their submission.

They shall show the design figures and the final operating values at which the systems andequipment are set by the commissioning Engineer.

e) Immediately upon completion of the commissioning work the Contractor shall forward to theProject Manager the completed record sheets for all plant and systems installed under this Contract.

2.26.3 Site Test

a) The Project Manager shall have power to inspect all work in progress and upon completion or substantial completion, and to require the Contractor to carry out tests in his presence or in the presence of his authorized representative in order to prove that all work carried out and all material, apparatus and equipment installed are wholly satisfactory and fully meet therequirements of this Specification.

b) Upon completion of the installation, or any substantial section thereof, the installation or thatsection and all of the associated equipment shall be subjected to the tests specified in the relevant British Standard. IEE Regulations and CIBSE standard; together with such other tests as may be required by the Project Manager in order to prove compliance with this Specification.

c) Tests not carried out in the presence of the Project Manager shall not be regarded as valid for the purpose of the Contract, unless the Project Manager shall have previously signified his inability to attend and shall have authorized the Sub-Contractor to proceed with the testing process in his absence.

d) The Project Manager and his authorized representative shall have unrestricted access on orabout the site of the works at all times during the site working hours, and at other times by agreement, for the purpose of carrying out inspections or witnessing tests upon the installations.

e) The Contractor shall ensure that the Project Manager is provided with adequate facilities forcarrying out such inspections as he may consider necessary, and that all tests are carried out in a safe and workmanlike manner complying with all relevant statutory safety requirements.

f) No material, apparatus, equipment, or installation shall be covered or otherwise permanentlyconcealed from view until the Project Manager has had the opportunity to inspect it or has given written authorization for covering to proceed following satisfactory tests and/or inspection.

g) No work shall be painted until it has been inspected by the Project Manager and/or painting has been authorized.

h) No inspection or testing by the Project Manager or his authorized representative nor the witnessing of satisfactory test shall in any way relieve the Contractor, nor shall it in any way limit the right of the Project Manager to reject such items if they subsequently prove to be defective or unsatisfactory or unsuitable for their intended purpose.

i) The Contractor shall be wholly responsible for time scheduling his work so that inspection and tests can be carried out as specified and the prescribed notice given to the Project Manager without delaying the completion of the works beyond the date set out in the approved construction Programme. No apparatus, equipment, plant, or installations will be recognized as complete and ready for taking over until after all of the specified inspections and tests have been satisfactorily carried out, and no claim for delay will be entertained unless it can be shown that the Project Manager has failed to carry out or to waive inspection after having been given the specified period of notice.

j) The Project Manager shall have the right to waive, at his sole discretion, the requirements in relation to inspection of materials, apparatus equipment and installations and the witnessingof tests thereon. The exercise of this right by the Project Manager shall not in any way relieve the Contractor of his obligations to carry out the prescribed tests and to submit test certificates.

k) If any fault or defect should come to light during the maintenance period in any of the apparatus, plant, equipment or installations, the Project Manager shall have power to requirethe Contractor to carry out further tests to isolate the fault or defect and subsequently to prove that the fault or defect has been remedied.

2.26.4 Performance Tests-General

a) Following receipt, checking and approval of the Contractor's commissioning reports by the Project Manager, the Contractor will be authorized to proceed with the system performancetests.

b) The Contractor shall give the Project Managers seven days' notice of his wish to demonstrate a system.

c) All tests shall last for the minimum time period stated or for a longer period if necessary to ensure all sections have been fully examined as required by the test.

d) All equipment, instrumentation, labour and attendance required for the tests shall be provided by the Contractor.

e) All water and electricity required for the Performance Tests will be provided by others via theinstallations covered by this Contract.

f) If, in the opinion of the Project Manager, the demonstration is unsatisfactory, or if any defects appear, a complete new set of tests shall be carried out at the Sub-Contractor's expense.

2.26.5 Warranties

The following warranties are required from the Contractor:

a) The Contractor shall warrant that the capacity, rating or duty of all equipment used in the installation shall not be less than the stated figures, when operating under the specified conditions. Any requirement found wanting in this respect shall be replaced entirely at the Contractor's expense.

b) The Contractor shall warrant that the mechanical and electrical services equipment when installed and operated in accordance with instructions supplied, will be capable of performing the duties as shown on the drawings or specification.

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2.26.6 Regulations

Unless expressly stated to the contrary, all materials and equipment supplied by the Contractor shall comply with the applicable provisions of all the relevant local Statutory Regulations, and allrelevant Codes, Standards and guidelines, and all its amendments; and all the local authorities having jurisdiction in the installation.

In the absence of the relevant codes and standards, other internationally recognized standards having authority in country of installation shall prevail.

Where a standard is referred to, that standard shall be the latest published edition thereof, unless otherwise stated.

Where the Contractor's standards differ from those specified but comply with the standards of the country of origin, the deviations shall be clearly indicated and the relevant published standards shall be included in the tendering documents. Such deviations shall be cross indexedwith the published standards.

The Contractor in carrying out the works described in this Specification shall comply in all respects with all the relevant requirements of:

1. India National Building Codes and Standards
2. Petroleum Rules and Act
3. Explosive Rules
4. ASME Boiler Codes
5. Indian Boiler Regulation (IBR)
6. Pollution Control Board (PCB) regulations
7. ASME Boiler Piping Codes
8. NEC : 1985 National Electrical Code 1985 Bureau of Indian Standards
9. IS : 3043: 1987 Code of Practice for EarthingIndian Standard
10. IS : 2309: 1989 Protection of Building and Allied Structures Against Lightning-Code of Practice
11. BS 7671 Wiring Regulation for Electrical Installation
12. Fire Protection Manual (12th Edition-1998) for Internal Appliance, Fire Engines, Trailer Pumps and Hydrant System by Tariff Advisory Committee.

3 FIRE FIGHTING & FIRE PROTECTION SYSTEM

3.1 Fire Protection Works for Building & Toll Plaza

Table 0-1 Fire Protection Scope of Work for Building & Toll Plaza

Sr. No.	Description	Detailed Scope
1.	BEST HV Switching Station, Sewri	Design, procurement, supply, transportation, installation, testing & commissioning of Fire Protection Designing / Provision shall be in accordance with latest IS & NBC 2016 a. Adequate Number of Applicable Fire Extinguishers in accordance to NBC 2016 Criteria / Local Fire Norms viz. (CO_2) Type & Sand Buckets to be Strategically Located.
2.	A. Main Central Command Centre, Gavan B. Sub Command Centre, Sewri C. Shivaji Nagar Command Centre.	a. Design, procurement, supply, transportation, installation, testing & commissioning of Fire Protection Designing / Provision shall be in accordance with latest IS & NBC 2016 b. UG Tank, OH Tank & Pump Capacities to be as per mentioned in NBC 2016 / CFO NOC. c. Allied Plant Room Size to be based on Actual Pump Capacities along with Piping, Valves etc. d. Internal Hydrant to Strategically Located near Staircase. e. External Hydrant along with Fire Bridge Inlet Connection & Draw Out Connection to Strategy Located. f. Sprinkler along with Piping to be provided in the Entire Building. g. Adequate No. of Applicable Fire Extinguishers in accordance to NBC 2016 Criteria / Local Fire Norms viz. (CO_2 / ABC) Type i.e. & Sand Buckets to be Strategy Located in the Entire Building. h. Piping upto Internal Hydrant Riser, Sprinkler Riser & External Hydrant Network.

3.	Porta Cabin	Design, procurement, supply, transportation, installation, testing & commissioning of Fire Protection Designing / Provision shall be in accordance with latest IS & NBC 2016 a. OH Tank & Pump Capacities to be as per mentioned in NBC 2016 / CFO NOC. b. Internal Hydrant to Strategy Located near Staircase. c. External Hydrant along with Fire Bridge Inlet Connection & Draw Out Connection to Strategy Located. d. Adequate No. of Applicable Fire Extinguishers in accordance to NBC 2016 Criteria / Local Fire Norms viz.(CO2 / ABC) Type & Sand Buckets to be Strategy Located in the Entire Building. e. Piping upto Internal Hydrant Riser & External Hydrant Network.
4.	A. 4 lane/ 6 lane Toll	Design, procurement, supply, transportation, installation,

Sr. No.	Description	Detailed Scope
	Plaza & Tunnel B. 16 lane Toll Plazawith Tunnel	testing & commissioning of Fire Protection Designing / Provision shall be in accordance with latest IS & NBC 2016 a. Adequate No. of Applicable Fire Extinguishers in accordance to NBC 2016 Criteria / Local Fire Norms viz.(CO2 / ABC) Type & Sand Buckets to be Strategy Located in Each Toll Booth & Tunnel Area.

3.2 Reference Standards

The Design & Planning of Fire Protection System shall be done keeping in view the following criteria:

- National Building Code 2016: Part IV for Fire & Safety
- Local Bylaws.
- Relevant BIS Codes: IS: 2190, IS: 3844, IS: 13039, IS: 15105, IS 12469
- NFPA – 13, 14 & 20
- Consultation with Local Chief Fire Officer (CFO) / In accordance to Fire NOC

3.3 Basis / Concept of Design

The Administration & Command Control Center Buildings Falls under Group-E of Business Building. The same comes under Moderate Hazard Category. The Fire Fighting Arrangement shall beDesigned as per the requirement of Local Guidelines & Engineering

Design Standards.

The Entire Fire Safety Installation shall be compliant with the Most Stringent Codes / Standard for the Entire Buildings to ensure the Highest Safety Standard and Uniformity of System. Further, beforeProperty is Opened / Handover to Use, the Fire Protection shall be fully Operated and Tested underSimulated Conditions to Demonstrate Compliance with the Most Stringent Standards, Codes and Guidelines.

Following functional system shall be provided; strictly in compliance with the listed reference standards:

a.	Piping System	:	Piping System Confirming to IS: 1239 and G.I. C Class Pipe
b.	Fire Water Static Storage	:	Fire Water Static Storage has been provided in Accordance toNBC 2016 / Fire NOC Requirement.
c.	Fire Pumping System	:	Pumping System Comprising of Independent Pumps for Hydrant, Sprinkler & Jockey Application has been provided along with Stand -by Diesel Engine Driven Pump.
d.	Hydrant System	:	External & Internal Hydrant complete with Hose Reel.
e.	Sprinkler System	:	Sprinkler System in the Entire Buildings. (APPLICABLE FOR MAIN ADMINISTRATION & COMMAND CONTROL CENTERBUILDING AND SUB ADMINISTRATION & COMMAND CONTROL CENTER BUILDING)
f.	Hand Held Fire Extinguishers	:	Strategically Placed at Designated Areas.

3.4 System Description

a. Fire Water Storage

Fire Fighting Provisions are proposed as per requirements mentioned in National Building Code2016: Part IV for Fire and Safety / Fire CFO NOC. Refer Annexure FF-01

Fire Department Connection shall also be provided on the External Wall of the Property nearthe Main Entrance. These shall comprise of 4 Nos. 63 mm dia. Male Outlets capable of Directly

Feeding the Ring Mains and External Hydrant System through Non Return Valves or Directly Filling the Static Fire Storage Tanks. These shall be mounted in specially identified Boxes. A Draw-Out Connection shall also be provided to Draw Water from the Static Storage Tanks if required.

b. Fire Pumping System

Water shall be drawn from Underground Fire Reserve Tanks by Electrically Driven Jockey Pumps, Fire Pumps and Sprinkler Pumps. All Pumps shall have separate Suction

Line from the Fire Suction Header and Delivery shall be connected to the System. For Sprinkler System, Installation Control Valve with Hydraulically Operated Alarm Gong shall be provided at Appropriate Places. The function of Pumps shall be to maintain 3.2 Kg/Sq.cm at the Top Most Hydrant. Diesel Engine Driven Stand-by Fire Pump shall be of the same Capacity and shall backup the Electrically Operated Main Fire Hydrant & Sprinkler Pumps, as per Fire Regulations. Independent Jockey Pumps (For Hydrant and Sprinkler Line Both) shall operate Intermittently in order to take care of Hydraulic Losses in the System and shall maintain the System Pressure in Wet Risers & Sprinkler System.

Fire Pumps' Rating / Duty are designed as per / as mentioned in NBC 2016 / Fire NOC.

c. Fire Pumps Requirement:

Refer Annexure FF-01

Electrical Pump shall provide Adequate Flow for catering requirement of Hydrant System as wellas Sprinkler System. Jockey Pumps shall Compensate for Pressure Drop and Line Leakage in the Hydrant and Sprinkler Installation.

Individual Suction Lines shall be drawn from the Fire Reserve Tanks Below Ground Level and connected to Independent Fire Pump Suction Header. The Electric Fire Pumps and the Jockey Pumps including Diesel Engine Driven Stand-by Pump shall all draw from this Suction Header.

Delivery Lines from Various Pumps shall also be connected to a Common Header in order to ensure that Maximum Standby Capacity is available. The Sprinkler Pump shall be isolated from the Main Discharge Header by a Non-Return Valve so that the Hydrant Pump can also act as Standby for the Sprinkler System. The Ring Main shall remain Pressurized at all times and Jockey Pumps shall make up for Minor Line Losses. Automation required to make the System Fully Functional shall be provided.

d. Fire Hydrant System

Internal and External Standpipe Fire Hydrant System shall be provided with Landing Valve, Hose Reel, First Aid Hose Reels, complete with Instantaneous pattern Short Gunmetal Branch Pipe in the All buildings.
The internal diameter of Inlet Connection shall be at least 150 mm for Double Outlet Hydrant Valves used Inside All Buildings. And the internal diameter of Inlet Connection shall be at least 80 mm for Single Outlet Hydrant Valves used in External Courtyards. The outlet shall be of Instant Spring Lock Type SS 316 ferrule coupling of 63 mm dia. for connecting to Hose Pipe.

Recessed Cupboard / Fire Hydrant Cabinet shall be strategically located for Firefighting Requirement. Location of Cabinets shall be easily accessible as per plan and shall be planned inconsultation with the Architect. Provision of Fire Man's Axe shall be made for Internal Hydrant.

Wet Riser Outlet & Hose Reel at a distance of 100 Ft. shall be provided.

External Hydrant shall be located with Min. Distance of 2 m upto Max. Distance of 15 m from theBuilding Line to be protected such that they are accessible and may not be damaged by VehicleMovement. Spacing between Two hydrants shall not be more than 30 m.

e. Sprinkler System

As per NBC / Fire CFO NOC requirements, it is required to provide Sprinklers in the Entire Building, including Car Parking. Sprinkler shall not be provided in Electrical Room, CCTV Roometc.

The Sprinkler System shall be provided with Control Valves, Flow and Tamper Switches at suitable location and shall be connected to Control Module of the Fire Alarm System for its Monitoring.

Sprinkler Type along with its Bulb Rating shall be selected based on the Requirement of the Space and shall be specified accordingly. Inspector's Test Valve Assembly with Sight Glass shall be provided at remote end with discharge piped to drain outlet / pipe.

f. Hand Held Fire Extinguishers

Portable Fire Extinguishers of Dry Powder (ABC Type), Water (Gas Pressure), Carbon-di-oxide and Foam Type shall be provided as First Aid Fire Extinguishing Appliances. These Extinguishers shall be Suitably Distributed in the All Areas of Building as well as Toll Booth in accordance with IS 2190 & provision mentioned in Fire CFO NOC. These shall be placed or hanged on wall in a group on several suitable places.
Classification of Extinguishers shall be as per the following table:

a. 02 Nos. of Dry Chemical Powder Type Fire Extinguishers of 09 Kgs. Capacity having IS. certification mark & 02 Bucket filled with Dry Clean Sand shall be kept in Electric Meter Room aswell as in Lift Machine Room.

b. 05 Nos. of Dry Chemical Powder Type Fire Extinguishers of 09 Kgs. Capacity having i's. certification mark & 05 Bucket filled with Dry Clean Sand shall be kept at Ground Level in Four Wheeler as well as Two Wheeler Parking Area.

c. 02 Nos. of Dry Chemical Powder Type Fire Extinguishers of 09 Kgs. Capacity having is. certification mark shall be kept on Each Floor Level.

d. 02 Nos. of Dry Chemical Powder (ABC) Type Fire Extinguishers of 09 Kgs. Capacity each shall be kept at the Entrance of the Fire Panels Room & Amenity Rooms.

e. 02 nos. of Dry Chemical Powder Fire Extinguishers A.B.C. type of 09 kgs. capacity each shall be kept at Every 100.00 sq. mtr.

Fire Fighting Requirement Data / Details
Refer Annexure FF-01

4 OUTLINE FIRE FIGHTING SPECIFICATIONS-BUILDING:

4.1 Scope

The scope of this section consists of but is not necessarily limited to supply, installation, testing andcommissioning of the fire protection system. The philosophy of the system is as follows :

a. The Fire Suppression System shall comprise the Fire Hydrants System, the Sprinkler System (Wet type), Hand Appliances.

b. Water from the underground___nos RCC Fire Water Storage Tanks, each of_cum capacity, shall be supplied for the uses listed below.

   i. Fire Hydrant System (Pressurized) both for the external hydrants, the internal landingvalves and the hose reels at landings.
   ii. Sprinkler System (Wet Type)
   iii. Drencher/Water Curtain system

c. The Hydrant System and the Sprinkler System, under normal conditions, shall be lowest pressurized by means of the electric motor driven Jockey Pump.

d. The Hydrant System shall be provided with two pump sets, one of which will be diesel engine driven and the other electric motor driven.

e. The Sprinkler System shall be provided with an electric motor driven pump set.

f. The piping and valve connections shall be done so that the water from the discharge of the Hydrant Pump sets is able to supply water, automatically to the Sprinkler System whenever, theSprinkler Pump is unable to maintain the pressure or fails and not vice versa.

g. The starting and stopping of the Jockey pump shall be automatic based on the pressure switches at preset low and high pressure.

h. The electric motor driven Hydrant Pump starts automatically at a preset pressure by means of apressure switch. As soon as the Hydrant Pump starts, the Jockey Pump Stops. If for any reason the electric motor driven Hydrant Pump does not start at the preset pressure or is unable to maintain the pressure, the diesel engine driven Hydrant Pump starts at the preset pressure.

i. The Hydrant Pump, whether electric motor driven or the diesel engine driven shall be stopped only manually.

j. The Sprinkler Pump shall be started automatically at a preset pressure but shall be stopped only manually.

k. Contractor shall ensure that all false ceiling voids greater than 800 mm are provided with sprinklers.

Contractor shall ensure Hydro Testing for the complete system.

m The Contractor shall obtain the necessary approval of the drawings and the schemes from the local authority / TAC as called for. The contractor shall also take care of any other requirement so that insurance cover can be obtained, if required, at minimum premium at a later date.

n. The contractor shall design and after approval of Project Manager display near each staircase landing at floor levels, a glass covered framed floor plan clearly showing the locations of all landing valves, hose reels, hand appliances, as well as the DO's and DON'T's for the personneland the exit direction in case of an emergency. The dimensions of the floor plan, its scale, lettering size, colour scheme etc. shall be as directed by the Project Manager.

4.2 Pipe Work

4.2.1 General Requirements

All materials shall be of the best quality conforming to the specifications and subject to the approvalof the Consultants.

Pipes shall be fixed in a manner as to provide easy accessibility for repair and maintenance and shall not cause obstruction in shafts, passages etc.

Pipes shall be securely fixed to walls and ceilings by suitable clamps and supports (galvanised after fabrication) at intervals specified. Only approved type of anchor fasteners shall be used for RCC slabs and walls / floors etc.

Valves and other appurtenances shall be so located that they are easily accessible for operations, repairs and maintenance.

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

Pipe accessories such as gauges, meters, control devices, etc. shall have the same working pressure rating as the associated pipe work. All pipe work shall be free from burrs, rust and scale and shall be cleaned before installation. All personnel engaged on welding operations must possess a certificate of competence issued by an acceptable / recognized authority.

4.2.2 Piping

Pipes of following types are to be used:

Mild steel black / Galvanised iron pipes as per IS:1239 heavy grade(for pipes of sizes 150 mm N.B.and below) suitably lagged on the outside to prevent soil corrosion. M.S./ GI pipes buried below ground shall also be suitably be lagged with 4 mm thick protection coating over 2 coats of primer.

GI/MS. Pipes upto 150 mm dia shall be as per IS: 1239, Part-I (heavy grade) while pipelines above150 mm dia shall be as per I.S.:3589.

All pipe clamps and supports shall be fabricated from MS steel sections and shall be factory galvanised before use at site. Welding of galvanised clamps and supports shall not be permitted.

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Pipes shall be hung by means of expandable anchor fastener of approved make and design. The hangers and clamps shall be fastened by means of galvanised nuts and bolts. The size/diameter ofthe anchor fastener and the clamps shall be suitable to carry the weight of water filled pipe and dead load normally encountered.

Hangers and supports shall be thoroughly galvanised after fabrication. The selection and design ofthe hanger & support shall be capable of carrying the sum of all concurrently acting loads. They shall be designed to provide the required supporting effects and allow pipeline movements as necessary. All guides, anchor braces, dampener, expansion joint and structural steel to be attached to the building/structure trenches etc. shall be provided. Hangers and components for all piping shall be approved by the Consultants.

The piping system shall be tested for leakages at 2 times the operating pressure or 1.5 time shut- off pressure, whichever is highest including testing for water hammer effects for a period of 4 hr. minimum.

Flanged joints shall be used for connections for vessels, equipment, flanged valves and also on two straight lengths of pipelines of strategic points to facilitate erection and subsequent maintenance work.

For pipes underground installation the pipes shall be buried at least one meter below ground level and shall have 230 mm x 230 mm masonry or concrete supports at least 300 mm high at 3 m intervals. Masonry work to have plain cement concrete foundation (1 cement: 4 coarse sand : 8 stone aggregate) of size 380 mm x 380 mm x 75 mm thick resting on firm soil.

Mains below ground level shall be supported at regular intervals not exceeding 3.0 metres and shallbe laid at least 2.0 metre away from the building.

4.2.3 Piping Installation & Support

Tender drawings indicate schematically the size and location of pipes. The Contractor, on the award of the work, shall prepare detailed working drawings, showing the cross-sections, longitudinal sections, details of fittings, locations of isolating and control valves, drain and air valves, and all pipe supports. He must keep in view the specific openings in buildings and other structure through which pipes are designed to pass.

Piping shall be properly supported on , or suspended from , on stands, clamps, hangers as specified and as required. The Contractor shall adequately design all the brackets, saddles, anchor, clamps and hangers, and be responsible for their structural stability.

Pipe work and fittings shall be supported by hangers or brackets so as to permit free expansion and contraction. Risers shall be supported at each floor with Galvanised steel clamps. To permitfree movement of common piping support shall be from a common hanger bar fabricated from Galvanised steel sections.

Pipe hangers shall be provided at the following maximum spacings:

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Pipe Dia (mm)	Hanger Rod Dia (mm)	Spacing between Supports (m)
Up to 25	6	2
32 to 50	6	2.5
65 to 80	8	2.5
80 to 100	10	2.5
125 to 150	10	3.0
200 to 300	12	3.5

The end of the steel rods shall be threaded and not welded to the threaded bolt.

All pipe work shall be carried out in a proper workman like manner, causing minimum disturbance to the existing services, buildings, roads and structure. The entire piping work shall be organized in consultation with other agencies work, so that area can be carried out in one stretch.

Cut-outs in the floor slab for installing the various pipes area are indicated in the drawings. Contractor shall carefully examine the cut-outs provided and clearly point out wherever the cut- outs shown in the drawings, do not meet with the requirements.

Pipe sleeves, larger diameter than pipes, shall be provided wherever pipes pass through walls and slab and annular space filled with fiberglass and finished with retainer rings.

The contractor shall make sure that the clamps, brackets, saddles and hangers provided for pipesupports are adequate or as specified / approved by Consultants. Piping layout shall take due care for expansion and contraction in pipes and include expansion joints where required.

All pipes shall be accurately cut to the required sizes in accordance with relevant BIS codes andburrs removed before laying. Open ends of the piping shall be closed as the pipe is installed to avoid entrance of foreign matter. Where reducers are to be made in horizontal runs, eccentric reduces shall be used for the piping to drain freely. In other locations, concentric reduces may be used.

Automatic air valves shall be provided at all high points in the piping system for venting. All valves shall be of 15 mm pipe size and shall be associated with an equal size gate valves. Automatic air valves shall be provided on hot water risers.

Discharge from the air valves shall be piped through a pipe to the nearest drain or sump. All pipes shall be pitched towards drain points.

Pressure gauges shall be provided as shown on the approved drawings. Care shall be taken to protect pressure gauges during pressure testing.

4.2.4 Pipe Fittings

Pipe fittings mean tees, elbows, couplings, unions, flanges, reducers etc. and all such connecting devices that are needed to complete the piping work in its totality.

Mild Steel / Galvanised Iron / Ductile Iron / Cast Iron / Forged steel screwed type fitting shall be used for pipes of 50 mm dia & below.

Fabricated fittings shall not be permitted for pipes diameters 50 mm and below.

Fabricated fittings used on pipe size 65 mm & above shall be fabricated , welded in workshops. They shall be inspected by Project Manager before dispatch from the workshop. The welding procedures of the workshop should have been approved by the rules for sprinkler system and applicable to hydrant and sprinkler system. For "T" connection, pipes shall be drilled and reamed. Cutting by gas or electrical welding shall not be permitted.

4.2.5 Procedure for Pipe Protection Application for Buried Pipes

A) Surface Preparation - The pipe surface shall be cleaned by a wire brush.

B) Application of Primer - Primer is to be applied on pipes immediately after cleaning. This is to prevent any further accumulation of rust on the pipe. This is a cold applied primer and is applied by brush.

C) Application of 4 mm bitumastic Tape - After the primer is applied on the pipe, it is allowed to dry for about 30 min. till it becomes touch dry. Before adhering the tape to the pipe, it is advisable to gently heat the primer coated pipe by a run of LPG torch. Remove the bottom polyethylene from the tape & then heat bottom surface of the tape by LPG torch or any heat source & start wrapping the tape to the pipe by heating the primer coated pipe & by removing the bottom polyethylene from the tape before wrapping better adhesion between the tape & pipe is obtained. Overlaps are maintained with a minimum of 15.0 mm.

D) Tape coating of weld joints - The tape is applied over the weld joints after the necessary welding & testing methods of the joints is completed. The procedure for application of tape shall be the same as bare pipe procedure. Overlaps on each side of the weld joints shall be 50 mm.

E) A final coat of White wash with water based cement paint is done immediately over the entire coated pipe.

4.2.6 Jointing

4.2.6.1 Welded Joints :

Joints between MS pipes and fittings shall be butt joint made with the pipes and fittings having "V"groove and welded with electrical resistance welding in an approved manner. But welding without "V" groove shall not be permitted.

4.2.6.2 Grooved Joints:

a. Remove all loose dirt scale & grease from the pipe surface.

b. Wrap the tape around the pipe, make sure the take is not twist & make the groove by machineas per the requirement of coupling manufacturer.

c. Joints between the pipes and grooved fitting shall be made with the pipe by making square groove by grooving machine without reducing the thickness of pipe wall and fixed with the helpof grooved coupling, nut, bolts & gasket etc.

4.2.6.3 Grooved Mechanical Couplings for Joining Carbon Steel Pipe :

Grooved Mechanical Couplings: Manufactured in two segments of cast ductile iron, conforming to ASTM A-536, Grade 65-45-12. Gaskets shall be pressure-responsive synthetic rubber, grade to suit the intended service, conforming to ASTM D-2000. (Gaskets used for potable water applications shall be UL classified in accordance with ANSI/NSF-61 for potable water service.) Mechanical Coupling bolts shall be zinc plated (ASTM B-633) heat treated carbon steel track head conforming to ASTM A-449 and ASTM A-183, minimum tensile strength 110,000 psi (758450 kPa) as provided standard.

a. Rigid Type: Coupling housings with offsetting, angle-pattern bolt pads shall be used to provide system rigidity and support and hanging in accordance with ANSI B31.1, B31.9, and NFPA 13.

b. Flexible Type: Use in locations where vibration attenuation and stress relief are required. Flexible couplings may be used in lieu of flexible connectors at equipment connections. Three Couplings shall be placed in close proximity to the vibration source.

c. Flange Adapters: For use with grooved end pipe and fittings, for mating to ANSI Class 125 / 150 flanges.

d. Grooved couplings shall meet the requirements of ASTM F-1476.

e. Gasket: Synthetic rubber, wide width, conforming to steel pipe outside diameter and coupling housing, manufactured of elastomers as designated in ASTM D-2000.

4.2.6.4 Grooved End Fittings

Fittings shall be cast of ductile iron conforming to ASTM A-536, Grade 65-45-12, with grooved ends for direct connection into grooved piping systems with steel forged steel conforming to ASTM A-234, Grade WPB 0.375" wall (9,53 mm wall), or fabricated from Std. Wt. Carbon Steel pipe conforming to ASTM A-53, Type F, E or S, Grade B. Fittings provided with an alkyd enamelfinish or hot dip galvanized to ASTM A-153 with fire lock arrangement. Zinc electroplated fittingsand couplings conform to ASTM B633.

4.2.6.5 Grooved Hole-Cut Branch Outlets:

a. Bolted Branch Outlet: Branch reductions on 21/2"(DN 65) through 6"(DN 150) header piping. Bolted branch outlets shall be manufactured from ductile iron conforming to ASTM A-536, Grade 65-45-12, with fire lock type synthetic rubber gasket, and heat treated carbon steel zinc plated bolts and nuts conforming to physical properties of ASTM A-183.

b. Strapless Outlet: 1/2"(DN 15) or 3/4"(DN 20) NPT outlet on 4" (DN 100) and larger header sizes rated for 300 PSI (2065 kPa).

c. Strapless Thermometer Outlet: To accommodate industrial glass bulb thermometerswith standard 1-1/4"-18 NEF 2B extra fine thread and 6" (152 mm) nominal bulb length on 4" (DN 100) and larger header sizes rated for 300 PSI (2065 kPa).

Lubricant for fixing the Gasket on pipe should be oil free by manufacture and capable to give the characteristic as required.

4.2.6.6 Flanged joints (65 mm dia and above)

Flanged joints with flanges conforming to IS: 6392 shall be provided on

a. Straight runs at intervals not exceeding 25-30m on pipe lines of 50 mm dia and above and as directed by the Project Manager.

b. For jointing all types of valves, appurtenances, pumps, connections with other type of pipes, to water tanks and other places necessary and as required for good engineeringpractice and as shown/noted on the drawings.

c. Flanges shall be with GI bolts and nuts and 3mm insertion gasket of natural rubber conforming to IS: 11149.

4.2.6.7 Unions (upto 50 mm dia)

Approved type of dismountable unions shall be provided on pipe lines of 40 mm dia and smallerdia, in locations similar to those specified for flanges.

4.2.6.8 Air Vessel

The air vessel shall be provided to compensate for slight loss of pressure in the system and to provide an air cushion for counter-acting pressure, surges, whenever the pumping sets come into operation. Air vessel shall conform to IS:3844. It shall be normally half full of water, when the system is in normal operation. Air vessel shall be fabricated with 8 mm thick M.S. plate withdished ends and suitable supporting legs. It shall be provided with one 100 mm dia flanged connection from pump, one 25 mm drain with valve, one water level gauge and 25 mm socketsfor pressure switches. The air vessel shall be tested to pressure for 12 hours at 2 times the operating pressure or 1.5 times the shut-off.

4.2.6.9 Air Cushion Tank

Every wet riser shall be provided with an air cushion tank at its top most point. The air cushion shall be provided with an automatic air release cock, 20 mm dia drain pipe, drain valve and shut off valve.

4.2.6.10 Fire Brigade Connection

The storage tank shall be provided with a 150 mm fire brigade pumping connection to discharge at least__litres / minute into it. The connection shall be fitted with stop valve in a position approved by the Project Manager. An overflow connection discharging to a drain point shall be provided from the storage tank.

The fire brigade connection shall be fitted with four numbers of 63 mm instantaneous inlets in aglass fronted wall box at a suitable position at street level, so located as to make the inlets accessible from the outside of the building. The size of the wall box shall be adequate to allow hose to be connected to the inlets, even if the door cannot be opened and the glass has to be broken. Each box shall have fall of 25 mm towards the front at its base and shall be glassed with wired glass with "FIRE BRIGADE INLET" painted on the inner face of the glass in 50 mm size block letter. Each such box shall be provided with a steel hammer with chain for breaking the glass.

In addition to the emergency fire brigade connection to the storage tank, a 150 mm common connection shall be taken from the four 63 mm instantaneous inlets direct to hydrant main so that the fire brigade may pump to the Fire Pump header in the event of the hydrant or sprinklerpumps being out of commission. The fire brigade pump shall charge the risers in this event. The connection shall be fitted with a sluice valve. Location of these valves shall be as per the approval of the Project Manager.

4.2.6.11 System Drainage

The system shall be provided with suitable drainage arrangement with drain valves complete with all accessories.

4.2.6.12 Valve Chambers

Provision of suitable brick masonry chambers in cement mortar 1:5 (1 cement : 5 coarse sand)on cement concrete foundations 150 mm thick 1:5:10 mix (1 cement : 5 fine sand : 10 graded stone aggregate 20 mm nominal size) with 15 mm thick cement plaster inside and outside finished with a plaster inside and outside finished with a floated coat of neat cement inside with cast iron surface box approved by fire brigade including excavation, back-filling complete shall be made.

4.2.6.13 Valves

a. Sluice Valves

Sluice valves shall be double flanged valves with cast iron body. The spindle, wall seat and wedge nuts shall be of bronze. They shall generally have non-rising spindle and shall be of theparticular duty and design called for.

The valves shall be supplied with suitable flanges, non- corrosive bolts and asbestos fibre gaskets. Sluice valves shall conform to Indian Standard IS : 14846 and IS : 2906

b. Butterfly Valve

The butterfly valve shall be suitable for waterworks and rated for Pressure requirement as mentioned in the Schedule of quantities.

The body shall be of cast iron to IS:210 in circular shape and of high strength to take the waterpressure . The disc shall be heavy duty cast iron with anti corrosive epoxy or nickel coating.

The valve seat shall be replaceable of high grade elastomer EPDM or nitrile rubber with hard backing. The valve is closed position shall have complete contact between the seat and the disc throughout the perimeter. The elastomer rubber shall have a long life and shall not give away on continuous applied water pressure. The shaft shall be EN 8 grade carbon steel.

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 leakages.

c. Ball Valve

The ball valve shall be made forged brass and suitable for test pressure of pipe line. The valve shall be internally threaded to receive pipe connections.

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.

The handle shall be provided 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 sealedto prevent water seeping.

The handle shall also be provided with a lug to keep the movement of the ball valve within 90°. The lever shall be operated smoothly and without application of any unnecessary force.

d. Gun Metal Valves

Gun metal Valves shall be used for smaller dia pipes, and for threaded connections. TheValves shall bear certification as per IS:778

The body and bonnet shall be of gun metal to IS:318. The stem gland and gland nut shall be offorged brass to IS:6912. The hand wheel shall be of cast iron to IS:210.

The Hand wheel shall be of high quality finish to avoid hand abrasions. Movement shall also beeasy. The spindle shall be non-rising type.

e. Flap Type - Non-Return Valve

Non-Return valves shall be cast iron double flanged with cast iron body and gun metal/ S.S. internal parts conforming to IS:5312.

f. Pressure Relief Valve

Each System shall be provided with a Pressure Relief Valves. The Valve shall be spring actuated and set to operate as per field requirement. The Valve shall be constructed of bronzeand provided with an open discharge orifice for releasing the water. The Valve shall be open lifttype. The valve shall be fitted on both ends of pump delivery header.

g. Pressure Switch

The pressure switches shall be employed for starting and shutting down operation of pumps automatically, dictated by line pressure. The Pressure Switch shall be diaphragm type. The housing shall be die cast aluminium, with SS 316 movement, pressure element and socket. The set pressure shall be adjustable.

The Switch shall be suitable for consistent and repeated operations without change in values. Itshall be provided with IP55 water and environment protection.

h. Pressure Gauge

Pressure gauge shall be provided near all individual connections of the hydrant system with isolation valves and near each flow switch assembly of the sprinkler system. Pressure gauge shall be 50 mm dia gunmetal bourdon type with gunmetal isolation ball valve, tapping and connecting pipe and nipple. The gauge shall be installed at appropriate height for easy readability.

4.2.6.14 Painting

All Hydrant and Sprinkler pipes shall be painted with post office red colour paint. All M S pipes shall first be cleaned thoroughly before application of primer coat. After application of primer coat two coats of enamel paint shall be applied. Each coat shall be given minimum 24 hours drying time. No thinners shall be used. Wherever required all pipe headers shall be worded indicating the direction of the pipe and its purpose such as "TO RISER NO.1" etc.

Painting shall be expertly applied; the paint shall not over run on surfaces not requiring painting such as walls, surfaces etc. Nuts and bolts shall be painted black, while valves shall be paintedblue.

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4.2.6.15 Excavation

Excavation for pipe lines shall be in open trenches to levels and grades shown on the drawingsor as required at site. Pipe lines shall be buried with a minimum cover of 1 meter or as shown on drawings.

Wherever required Contractor shall support all trenches or adjoining structures with adequate timber supports, shoring and strutting.

On completion of testing in the presence of the Project Manager and pipe protection, trenches shall be backfilled in 150 mm layers and consolidated.

Contractor shall dispose of all surplus earth as directed by the Project Manager.

4.2.6.16 Anchor / Thrust Block

Contractor shall provide suitably designed anchor blocks in cement concrete/steel support tocater to the excess thrust due to work hammer and high pressure

Thrust blocks shall be provided at all bends, tees and such other location as determined by theProject Manager.

Exact location, design, size and mix of the concrete blocks/steel support shall be as shown onthe drawings or as directed by the Project Manager prior to execution of work.

4.2.6.17 Fire Sealant

a. Fire Barrier for Ducts:

Application of fire resistance rectangular, square or circular duct system (vertical as well horizontal orientation) for two hours stability, integrity and insulation with flexible non- asbestos wrap system of minimum 96kg/m3 density, 38 mm thick and R-value 0.89 m°K/ Wconsisting of inorganic fiber blanket.

Fire Barrier Duct Wrap shall confirm to ASTM E 814, ASTM E119, Non-combustibility to ASTM E 136, Durable to ASTM C 518 and IECC Requirements for Interior Ducts. The ventilation ducts (Duct A) shall conform to ISO 6944-1985 and the grease duct (Duct B) conforms to ASTM E2336-04 (2009), ICC-ES.

The impaling pins of minimum 12 GA, 114 mm (Duct A -one layer wrap) or 165 mm (duct B -two layer wrap) long copper coated steel insulation pins are to be installed on the bare duct,then the flexible wrap is installed and finally self-locking insulation washers of minimum 63.5mm by 63.5 mm slid over the pins. The insulated cup-head pins are installed after the wrap.The space pins to be fixed maximum 305 mm apart along the width and maximum 170 mm from the edges. When required banding is applied around the duct 38 mm from each edge of the blanket and a maximum 265 mm on centers. All the transverse overlaps should be staggered. All the exposed joints to be sealed with 102 mm wide pressure sensitivealuminum foil tape and fire barrier sealant. The steel duct should meet the SMACNA, NFPA90 A & 96. The annular space around the duct to be protected with UL/ Intertek certified penetration seals with a collar on each side. The system should meet the intent of LEED& VOC Regulations. All above mentioned standard are as per latest edition with amendments.

b. Fire sealing of Through Penetrations, with small to medium size cut outs, in wall orFloor:

Application of fire resistance large penetration seals in the fire rated assemblies in walls andfloors using white color water based, halogen free intumescent coating of 2 mm thick and density 1.3 kg/liters to be applied to mineral wool board. The two coated mineral wool boards are to be inserted into the void one from each side of the wall or floor and fitted around the services. All gaps are to be filled with fire resistance sealant to give a cold-smokeseal. The surfaces of the sealant and 50 mm out from the opening are to be coated with a final layer of coating. The electrical cables are to be coated over a distance of 150 mm fromeach side of the seal. The intumescent coating should expand up to 10 times forming an insulating char to fill the voids. The perimeter of the metallic pipes and ducts with insulation to be sealed with intumescent fire resistance sealant and plastic pipes to be protected using intumescent wrap strips with restricting collars of same fire resistance requirement. The system to be tested for penetrations seals in walls and floors up to 2 hours as per BS 476: Part 20 -1987. The system should meet the intent of LEED® VOC Regulations. All above mentioned standard are as per latest edition with amendments. The fire resistance penetration seals should be done by authorized applicators of the manufacturer and system certification provided by manufacturer on completion.

Application of fire resistance large penetration seals in the fire rated assemblies using endothermic gypsum-based material Mortar passing through fire-rated floor or wall assemblies and other fire-rated interior building construction. All the mechanical and electrical service penetrations, blank openings and other large annular spaces to be sealed with endothermic mortar for a fire resistance up to two hours and having a compression strength of minimum 1.3 MPa (186 PSI). The system to be tested in accordance with AS1530 -4, EN1366, ASTM E814 and UL 1479. The perimeter of the metallic pipes and ducts with insulation to be sealed with intumescent fire resistance sealant and plastic pipes to be protected using intumescent wrap strips with restricting collars of same fire resistance requirement as per UL 1479 standards. The system should meet the intent of LEED® VOC Regulations. All above mentioned standard are as per latest edition with amendments. The fire resistance penetration seals should be done by authorized applicators of the manufacturer and system certification provided by manufacturer on completion.

Application of fire resistance large penetration seals in the fire rated assemblies using elastomeric intumescent composite sheet (single layer in floor openings and two layers in the wall openings) of minimum 7.62 mm thick and density of 13.4 kg/m2. The fire resistanceelastomeric composed of 28-gauge galvanized steel on one side (outward side) and the other with steel-wire mesh and covered with aluminum foil, when exposed to temperatures more than 250°F (121°C) the fire-resistive sheet should volumetrically expand and swells 10times its original size, forming a high strength, hard char that retards heat transmission through the openings. The elastomeric composite sheet should have an overlap minimum 51 mm around the perimeter of the opening and secured using 6.35 mm x 38.1 mm steel masonry fasteners at 152.4 mm center to center. The perimeter of the opening and services passing through to be sealed with fire barrier sealant having 4 hours fire resistance, or with 3mm Moldable Putty+ against smoke and flame propagation. The plastic pipes to be protected with intumescent wrap strips with restricting collars. The intumescent sheet is tested up to 4 hours fire resistance as per ASTM E 814 and UL.

1479. Electrical circuits' protection systems for cable trays besides meeting surface burning characteristics ASTM E84 and UL 723 The system to be resistance to mold and fungi as per ASTM G21. The system should meet the intent of LEED® VOC Regulations. All above mentioned standard are as per latest edition with amendments. The fire resistance penetration seals should be done by authorized applicators of the manufacturer and system certification provided by manufacturer on completion.

c. Fire and Water Barrier Tape: Fire Sealing of Construction Joints as per UL 2079/ASTM E1966:

Application of fire resistance perimeter joints (curtain wall), construction joints, and through penetration openings in the fire rated assemblies using a self-adhered firestop membrane 0.25 mm thick that should provide a tough, elastomeric coating compatible to a wide variety of substrates even to damp surfaces. The system should have a compression/extension recovery of minimum +/- 50 percent of joint width (movement capabilities) as per ASTM E1966, ASTM E2837 and should act as a barrier to fire, heat, smoke, water leakage and airborne sound transmission minimum STC 54 as per ASTM E90/ ASTM E413. The self- adhered firestop membrane should be fixed onto the mineral wool of minimum density 64kg/m3 and thickness of minimum 25% greater than the gap width to provide a fire resistance of minimum two hours in construction joints per ASTM E1966 (UL 2079), in perimeter joints as per ASTM E2307 and penetration seals as per ASTM E814 (UL 1479). The self-adhered firestop membrane should have a flame spread index: 10 and smoke developed value: 10 as per the surface burning characteristics as per ASTM E84. Should have minimum adhesion to concrete greater than 55 oz./inch as per ASTM D3330, rain resistance as per ASTM D6904, tensile strength greater than 2100 psi and elongation morethan 500% as per ASTM D882, water vapor transmission 0.19 perms as per ASTM E96. Should have a minimum L-rating of 1 cfm per linear foot for the smoke movement and Class1 for W rating of water tightness per ANSI/UL 1479. The system to be resistance to mold and fungi as per ASTM G21. The system should meet the intent of LEED® VOC Regulations and should be paintable. All above mentioned standard are as per latest editionwith amendments. The fire resistance penetration seals should be done by authorized applicators of the manufacturer and system certification provided by manufacturer on completion.

4.2.6.18 Fire Hydrants

a. External Hydrants

i Contractor shall provide external hydrants. The hydrants shall be controlled by a cast iron sluice valve. Hydrants shall have instantaneous type 63 mm dia outlets. The hydrants shallbe single outlet conforming to IS:908 to required height to bring the hydrant to correct levelabove ground.

ii. Contractor shall provide for each external fire hydrant two numbers of 63 mm dia. 15 m long controlled percolation hose pipe with gunmetal male and female instantaneous type couplings machine wound with GI wire (hose to IS:636 type certification) , gunmetal branchpipe with nozzle to IS:903. This shall be measured and paid for separately.

iii. Each external hydrant hose cabinet shall be provided with a drain in the bottom plate.

iv Each external hydrant hose cabinet containing items as above shall also be provided with a Fireman's Axe. This shall be measured and paid for separately.

v. Each hose cabinet shall be conspicuously painted with the letters "FIRE HOSE".

Note: As per NBC and IS Standards, spacing between External hydrants shall be 60 m for light hazard, 45 m for moderate hazard and 30 m for high hazard. Also CFO's provisional NOC to be referred and decided.

b. Internal Hydrants

a. Contractor shall provide on each landing and other locations as shown on the drawings double headed gunmetal landing valve with 100 mm dia inlet as per IS:5290, with shut off valves having cast iron wheels as shown on the drawings. Landing valve shall have flangedinlet and instantaneous type outlets as shown on the drawings.

b. Instantaneous outlets for fire hydrants shall be standard pattern and suitable for fire hoses.

c. Internal Fire Hose Cabinet

Hose cabinet shall be of glass fronted with hinged door & lock. The cabinet shall be made of 16 gauge thick MS/SS (as per SOQ) sheet and spray painted to shade No. 536 of IS:5. The hose cabinet shall be of size to accommodate the following:

i. Landing Valves (Single/double headed)

ii. Hose pipe (2 or 4 length of 15M)

iii. Hose reel (~~36.5~~ 36.0 mtr.)

iv. Branch pipes, nozzles (one / two sets)

v. Fire man's axe and hand appliances

a. Contractor shall provide for each internal fire hydrant station two numbers of 63mm dia. 15 m long rubberized fabric lined hose pipes with gunmetal male and female instantaneous type coupling machine would with GI wire (hose to IS:636 type 2 and couplings to IS:903 with IS certification), fire hose reel, gunmetal branch pipe with nozzle to IS:903. This shall be measured and paid for separately.

b. Contractor shall provide standard fire hose reels of 20 mm dia high pressure dunlop rubber hose 36 m long with gunmetal nozzle, all mounted on a circular hose reel of heavy duty mild steel construction having cast iron brackets. Hosereel shall be connected directly to the wet riser with an isolating valve. Hose reel shall conform to IS:884 and shall be mounted vertically . This shall be measured and paid for separately.

c. Each internal hydrant hose cabinet shall be provided with a drain in the bottomplate. The drain point shall be lead away to the nearest general drain.

d. Each internal hydrant hose cabinet containing items as above shall also be provided with ~~and~~ a Fireman's Axe. The cabinet shall be recessed in the wall as directed. This shall be measured and paid for separately.

e. Each hose cabinet shall be conspicuously painted with the letters "FIREHOSE".

d Hose Reel

Hose reel shall conform to IS : 884, heavy duty, 20 mm dia length shall be 36 metre long fitted with gun metal chromium plated nozzle, mild steel pressed reel drum which can swing upto 170 degree with wall brackets of cast iron finished with red and black enamel complete.

e Fire Hose

All hose pipes shall be of 63 mm diameter RRL/ CP as required, conforming to IS : 636or IS : 8423. The hose shall be provided with copper alloy delivery coupling. The hose shall be capable of withstanding a bursting pressure of 35.7 Kg/Sq.cm without undue leakage or sweating. Hose shall be provided with instantaneous spring-lock, type couplings.

f Branch Pipe, Nozzle

Branch pipes shall be of gun metal with loaded tin bronze ring at the discharge and to receive the nozzle and provided at the other with a leaded tin bronze ring to fit into the instantaneous coupling. Nozzle shall be of spray type of diameter of not less than 16 mm and not more than 25 mm. Nozzle shall be of loaded tin bronze branch pipe and nozzle shall be of instantaneous pattern conforming to Indian Standard - 903.

g Hose Cabinet

Hose cabinet shall be provided for all internal and external fire hydrants. Hose cabinets shall be fabricated from 16 gauge MS/SS (as per SOQ) powder coated sheet of fully welded construction with hinged double front door partially glazed (3 mm glass panel) with locking arrangement, stove enameled fire red paint (shade No. 536 of IS:5) with "FIRE HOSE" written on it prominently (size as given in the schedule of quantities). Cabinet surfaces in contact with the walls shall not be powder coated but instead giventwo coats of anti-corrosive bitumastic paint.

h External Hose Cabinet

The hose cabinet shall be of size to accommodate the following:

i. Single/Double headed yard hydrant valve
ii. Hose pipe (2 length of 15 m)
iii. Branch pipes, nozzles (one / two sets)
iv. Fire man's axe

4.2.6.19 Sprinkler System

i. General Specification

The scope of work shall include supply, installation , testing and commissioning, of the system as awhole. The sprinkler heads are to be fixed into heavy quality black steel pipes, conforming to IS 1239 or any other approved specification. The size of pipe will

vary from 20 mm to 150 mm to suit the hydraulics of the system. The System shall conform to CFO Rules for the installation of sprinkler systems in general for 'Ordinary Hazard' category-in respect of design, density and spacing of sprinkler heads.

Reduction in pipe sizes shall not be made by use of bushings. All piping shall be done by meansof welding, screwed & flanged jointing as per codes.

Due care shall be taken that sprinklers are not applied with paint at the time of applying paint topiping and fittings.

All control, drain, test and alarm valves shall be provided with signs to identify their purposes,functions, direction of flow the satisfaction of the Consultants.

ii. Quartzoid Bulb Automatic Sprinkler

Sprinkler heads shall be made of brass/quartzoid bulb sufficiently strong, in compression to withstand any pressure, surge or hammer likely to occur in the system. The yoke & body shall be made of high quality gun metal brass with arms streamlined to ensure minimum interference with the spread of water. The deflector of suitable design shall be fitted to give even distribution of waterover the area commanded by the sprinkler.

The bulb shall contain a liquid having a freezing point below any natural climatic figure and a high coefficient of expansion. The temperature rating of the sprinkler shall be stamped on the deflector &the colour of the liquid filled in the bulb shall be according to the temperature rating as per NFPA standard. The sprinkler heads shall be of type & quality approved by the local fire brigade authority.The inlet shall be screwed.

The sprinklers shall have 15 mm nominal size of the orifice for ordinary hazard.The orifice size shall be marked on the body or the deflector of the sprinkler.

Metal guards for protection of sprinkler against accidental or mechanical damage shall be providedas desired by the Project Manager.

Contractor shall submit detailed submittal and discharge spray pattern for the Sprinkler for theapproval of consultant.

iii. Operating Temperature

The Operating temperature at which the quartzoid bulb of the sprinkler head shall actuate, shall be68 degree C or as specifically mentioned.

iv Sprinkler Installation

Sprinkler heads shall be located in positions shown on the drawings. While slight relocation may result from building construction features or interference from other services, the maximum spacing between sprinkler heads and coverage area shall not exceed those stipulated in the TAC regulations and the NFPA 13-1994 Rules.

Allowance shall be made for such relocations within a radius of 1500 mm of the indicated positions without additional cost. The Fire Protection Services Trade shall co-ordinate with the ceiling Trade to set out the sprinkler locations to suit the site location of the unit grid. In general,all sprinklers shall be located at the centre of the ceiling unit and a provision of about 10% moresprinklers and pipe work than required in TAC and NFPA Rules shall be included in this sub- contract. Chrome plated wire mesh guards shall be used to protect the sprinkler heads which areliable to accidental or mechanical (at no

extra cost) damage.

v **Flow Requirements**

The flow requirement for sprinkler heads shall be specifically approved for the designated area of installation.

vi **Orifice Plates**

For restricting pressure at lower levels in the sprinkler system, orifice plates of appropriate sizes shall be fitted at different floor levels, at the branching points from Riser Main.

The Diameter of such orifice shall not be less than 50% of the dia of pipe into which it is to be fitted, which shall not be less than 50 mm dia. These orifice plates must be of stainless steel with plain central hole without burrs, and the thickness shall be 3 mm for pipe size upto 80 mm, 6 mm for pipes from 80 to 125 mm dia and 9 mm for pipes greater than 125 mm dia. Such orifice plate musthave a projecting identification tag.

The orifice plate shall fitted not less than two pipe internal diameters down stream of the outlet fromany elbow or brand.

Contractor shall submit the design and identify location on drawing before installation.

vii **Installation Control Valves**

Each installation shall be provided with a set of installation control valves comprising:-

a. An Alarm Valve.

b. A Water Motor Alarm & Gong.

c. Installation valves shall be installed on the sprinkler circuits as shown on the drawings.

d. Contractor shall submit detailed shop drawings showing the exact location, details of installationof the valves/alarm in all respects.

e. Installation valve shall comprise of a cast iron / ductile iron body with gunmetal trim, and doubleseated clapper check valves, pressure gauges, test valve and orifice assembly and drain valvewith pressure gauges, turbine water gong including all accessories necessary and required and as supplied by original equipment manufacturer and required for full and satisfactory performance of the system. A cast iron isolation valve with lock and chain at the inlet of the installation valve shall be provided.

viii **Inspection and Test Valve Assembly**

Inspection and testing of the automatic starting of the sprinkler system shall be done by providing an assembly consisting of gunmetal valves, gunmetal sight glass, bye-pass valve and orifice assembly as per approved drawing.

ix **Flow Switch**

Flow switch shall have a paddle made of flexible and sturdy material of the width to fit within the pipe bore. The terminal box shall be mounted over the paddle/ pipe through a connecting socket. The Switch shall be potential free in either N O or N C position as required. The switch shall be ableto trip and make / break contact on the operation of a

single sprinkler head. The terminal box shall have connections for wiring to the Annunciation Panel. The flow switch shall have connections for wiring the seat shall be of Stainless steel (SS) to the Annunciation Panel. The flow switch shall have IP: 55 protections.

The flow switch work at a triggering threshold bandwidth (flow rate) of 4 to 10 GPM. Further, it shallhave a 'Retard' to compensate for line leakage or intermitted flows.

4.2.6.20 The Main Stop Valve

These shall be of cast iron body of requisite size. When closed, these will shut off supply of water tothe installation.

A location plate must be fixed on the outside or an external wall, as near to the main stop valve as possible, bearing the following words on raised letters or other approved type letter.

i **Sprinkler Stop Valve Inside :** The word `sprinkler stop valve' shall be in letters of at least 35 mm and the word "INSIDE" at least 25 mm in height. The words shall be painted white on blackback ground.

ii All stop valves shall be right handed i.e. they shall be so constructed that in order to shut the valve the spindle shall turn from left to right. There shall be an indicator which will show whether the valve is open or shut.

4.2.6.21 Pipes for Drainage:

Sprinkler pipes shall be so installed that the system can be thoroughly drained. As far as possibleall pipes shall be arranged to drain to the installation drain valve as shown in the drawing for ordinary hazard system.

In the case of basement & other areas where sprinkler pipe-work is below the installation drainvalve & in other trapped points in the system, auxiliary valves of the following sizes shall be provided.

-20 mm valves for pipes upto 50mm dia.

-25 mm valves for 80mm dia pipe.

-50 mm valves for pipes larger than 80 mm dia.

4.3 System Design

The entire sprinkler installation shall be designed to make it a hydraulically balanced system. Thepressure requirement at typical floors shall be designed between 2.5 bar and 3.5 bar.

4.3.1 Hand Held Fire Extinguishers

4.3.2 Hand Appliances

4.3.2.1 Scope

Work under this section shall consist of furnishing all labour, materials, appliances and equipment necessary and required to install fire extinguishing hand appliances as per relevant specification ofvarious authorities.

Without restricting to the generality of the foregoing, the work shall consists of the following:

Installation of fully charged and tested fire extinguishing hand appliances of A B C powder type as required and specified in the drawings and schedule of rates.

4.3.2.2 General Requirements

Hand appliances shall be installed in easily accessible locations with the brackets fixed to the wallby suitable anchor fasteners.

Each appliance shall be provided with an inspection card indicating the date of inspection, testing,change of charge and other relevant data.

All appliances shall be fixed in a true workmanlike manner truly vertical and at correct locations. Distribution / installation of fire extinguisher to be in accordance to IS:2190. Fire Extinguisher shall be selected by referring the Table below:

Sr.No	Description	Category/Class of Hazard	Details
1.	UPS room	SH (Special Hazard)	CO2 4.5 kg or Clean Agent 2 kg- Recommended Clean Agent.
2.	Electrical Room (floor level)	SH (Special Hazard)	Clean Agent 2 kg
3.	D.G Room	MH (Medium Hazard)	Mechanical Foam 9 lit or 6 Kg ABC type
4.	Server Room	SH (Special Hazard)	Clean Agent 2 Kg.
5.	Conference Room	SH (Special Hazard)	Clean Agent 2 Kg.
6.	Car Parking Area	MH (Medium Hazard)	6 Kg ABC type
7.	Store Room	MH (Medium Hazard)	6 Kg ABC type
8.	Training Room	SH (Special Hazard)	Clean Agent 2 Kg.
9.	Discussion Room	SH (Special Hazard)	Clean Agent 2 Kg.
10.	Canteen / Kitchen	LH (Low Hazard)	9 Lit Foam type or 6 Kg ABC
12.	LPG Bank	MH (Medium Hazard)	Mechanical Foam 9 lit or 6 Kg ABC type
13.	Board Room	LH (Low Hazard)	6 Kg ABC type
14.	AHU Room	MH (Medium Hazard)	6 Kg ABC type

15.	Reception Area	SH (Special Hazard)	Clean Agent 2 kg
16.	Security Cabin	SH (Special Hazard)	Clean Agent 2 kg
17.	Transit quarters	LH (Low Hazards)	6 Kg ABC type
18.	Doctor's room	MH (Medium Hazard)	6 Kg ABC type
19.	Administrative office	SH (Special Hazard)	Clean Agent 2 kg
20.	BMS room	SH (Special Hazard)	Clean Agent 2 kg
21.	Fire Pump room	SH (Special Hazard)	CO2 4.5 Kg
22.	Lift Machine room	SH (Special Hazard)	CO2 4.5 Kg

4.3.2.3 ABC Type Dry Powder Extinguisher

The Extinguisher shall be filled with ABC grade 40, Mono Ammonium Phosphate 40% from any approved manufacturer.

The capacity of the extinguisher when filled with Dry Chemical Powder (First filling) as per IS 4308,Part II, shall be 4 Kg +/-2% or 9 Kg +/- 3%.

The distribution of fire extinguishers to be as per IS 2190 – 1992.

It shall be operated upright, with a squeeze grip valve to control discharge. The plunger neck shall have a safety clip, fitted with a pin, to prevent accidental discharge. It shall be pressurised with DryNitrogen, as expellant. The Nitrogen to be charged at a pressure of 15 Kg/cm^2

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 braided nylon. The body shall be cylindrical in shape, with the dish and dome weldedto it. Sufficient space for Nitrogen gas shall be provided inside the body, above the powder filling.

The Neck Ring shall be externally threaded - the threading portion being 1.6 cm. The filler openingin the neck ring shall not less than 50 mm. Discharge nozzle 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 mtr, continuously, at least for 15 seconds. The hose, forming part of discharge nozzle, shall be 500 mm long, with 10 mm dia internally for 5 Kg capacity and 12 mm for10 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 itshall 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/cm^2 for a minimum period of 2 minutes. The pressure gauge shall be imported and suited for the purpose.

4.3.2.4 Water Type Extinguisher (Gas Pressure Type)

The Extinguishing medium shall be primarily water stored under normal pressure, the discharge being affected by release of Carbon Dioxide Gas from a 120 gms cylinder.

The capacity of Extinguisher, when filled upto the indicated level, shall be 9 ltr +/- 5%.

The skin thickness of the Cylinder shall be minimum 4.0 mm, fabricated from Mild Steel sheet, welded as required, with dish and dome, being of same thickness, and of size not exceeding the diameter of body. The diameter of body to be not less than 150 mm and not exceeding 200 mm. The neck shall be externally threaded upto a minimum depth of 16 mm, and leaded tin bronze.

The cap shall be of leaded tin bronze and screwed on the body upto a minimum of 1.6 cm depth, with parallel screw thread to match the neck ring. The siphon tube to be of brass or G.I. and the strainer of Brass. The cartridge holder, knob, discharge fittings and plunger to be of Brass/Leaded tin bronze, and plunger of stainless steel, spring of stainless steel. The cap to have handle fixed to it. The discharge hose shall be braided nylon, of 10 mm dia and 600 mm long, with a nozzle of brass fitted at end.

The extinguisher shall be treated for anti-corrosion internally and externally, and externally paintedwith Fire Red paint. The paint shall be stove enameled/powder coated. The cartridge shall be as per IS and have 60 gm net carbon dioxide gas for expelling. The extinguisher, body and cap shall be treated to an internal hydraulic pressure of 25 Kg/cm2. It shall have external marking with letter A, of 2.5 cm height, in block letters within a triangle of 5 cm each side. The extinguisher shall be upright in operation, with the body placed on ground and discharge tube with nozzle held in one hand to give a throw of not less than 6 mtr and continue so for atleast 60 secs. The extinguisher body shall be clearly marked with ISI stamp (IS:15683 2006).

4.3.2.4 Carbon Dioxide Extinguisher

The Carbon Dioxide Extinguisher shall be as per IS: 2878

The body shall be constructed of seamless tube conforming to IS:7285 and having a convex domeand flat base. Its dia shall be maximum 140 mm, and the overall height shall not exceed 720 mm.

The discharge mechanism shall be through a control valve conforming to IS:3224. The internal syphon tube shall be of copper aluminium conforming to relevant specifications.

Hose Pipe shall be high pressure braided Rubber hose with a minimum burst pressure of 140 Kg/cm2 and shall be approximately 1.0 meter 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 hand grip of Discharge horn shall be insulated with Rubber of appropriate thickness.

The gas shall be conforming to IS:307 and shall be stored at about 85 Kg/cm2. The expansion ratiobetween stored liquid carbon dioxide to expanded gas shall be 1:9 times and the total discharge time (effective) shall be minimum 10 secs and maximum 25 secs.

The extinguisher shall fulfill the following test pressures:

Cylinder: 236 Kg/cm2 Control Valve: 125 Kg/cm2
Burst Pressure of Hose: 140 Kg/cm2 minimum

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.

The Extinguisher including components shall be IS marked.

4.3.2.5 **Detail Specifications of Fire Extinguishers**

a. **Dry Powder ABC-50% (Stored Pressure) 6 Kg**

6 kg Fire Extinguisher Mono Ammonium Phosphate Powder 50% for 6 Kgs conform to IS14609 Applicable fire classes AB & C, Controllable discharge mechanism with EPDM Hose & Nozzle, UGTS Pressure Gauge,Body Construction Deep Drawn with MIG Welding technology, External Pure polyester and Internal Epoxy polyester powder coated, Brass forged valves with safety Pin is of SS material, and Welding Procedure approved by TPI with 6 G certification. **Fire Class 3A &** valves with safety Pin is of SS material, and Welding Procedure approved by TPI with 6 G certification. **FireClass 3A & 21B (Tested upto 34B) rating** as per IS 15683 and ISI MARK.

b. **Dry Powder ABC-90% (Stored Pressure) 6 Kg**

Fire Extinguisher Mono Ammonium Phosphate Powder 90%, Applicable fire classes AB & C, Controllable discharge mechanism with EPDM Hose & Nozzle, UGTS Pressure Gauge, Deep Drawn with MIG Welding technology, External Pure polyester and Internal Epoxy polyester powder coated, Brass forged valves with safety Pin is of SS material, and Welding Procedure approved by TPI with 6 G certification. **Fire Class 3A & 21B (Tested upto 55B) rating** as per IS15683 and ISI MARK.

4.3.2.6 **Water (Stored Pressure) 9 Ltr.**

a. **9 ltr. Fire Extinguisher Water type.** Applicable fire class A, Controllable discharge mechanism with EPDM Hose

Nozzle, UGTS Pressure Gauge, Body Construction Deep Drawn with MIG Welding technology, External Pure polyester powder coated and Internal Plastic lining, Brass forged valves with safety Pin is of SS material, and Welding Procedure approved by TPI with 6 G certification. **Fire Class 3A rating** as per IS 15683 and ISI MARK.

4.3.2.7 **Mechanical Foam (Stored Pressure) 9 Ltr.**

a. **9 ltr. Fire Extinguisher AFFF Foam (6%) type.** Applicable fire class A & B, Controllable discharge mechanism With EPDM Hose & Foam making Nozzle, UGTS Pressure Gauge, Deep Drawn with MIG Welding technology, External Pure polyester powder coated and Internal Plastic lining, Brass forged valves with safety Pin is of SS material, and Welding. Procedure approved by TPI with 6 G certification. **Fire Class 4A & 34B rating** as per IS 15683 and ISI MARK.

4.3.2.8 **CO2 (High Pressure) 4.5 Kg**

a. **4.5 kg High Pressure Portable Fire Extinguisher,** CO2 Gas as per IS 15222 for Fire Classes BC & Electrical

b. **4.5 kg High Pressure Portable Fire Extinguisher,** CO2 Gas as per IS 15222 for Fire Classes BC & Electrical Fires, Discharge Control mechanism fitted with high pressure steel braided Discharge Hose and Flat Horn with diffuser

Nozzles for dispersed discharge of CO2, Internal coating is not applicable & External coating is of enamel spray painting, Cylinders construction: hot spinning seamless & bearing ISI mark, confirms to IS 7285 and PESO/CCOE Nagpur Approved. **Fire Class**

21B rating as per IS 15683and ISI MARK.

4.3.2.9 Clean Agent (Fe 36) 2 Kg

Fire Extinguisher "DUPONT " Make UL listed FE-36 (HFC-236 fa) gas Electrically nonconductive, non-corrosive, colorless and non-residual clean agent Suitable for Class A, B, C,and electrical fires approved with US EPA (Environmental Protection Agency) , , listing under USA Signification New Alternative Policy ((SNAP) & also approved by (Environmental Protection Agency) listing under USA Signification New Alternative Policy SNAP) & also approved by UL, compliant with ASTM -D6541-11. KANEX FE-36 Fire Extinguishers having **Zero Ozone Depletion Potential (ODP), 2 Kgs.**

Low toxicity, also its replacement for Halon 1211, Halon 1201. Controllable discharge mechanism with **EPDM Discharge Hose with Specially designed Unique Nozzle,** UGTS Pressure Gauge, Body Construction Deep Drawn with MIG Welding technology, External Pure polyester and Internal Epoxy polyester powder coated, Brass forged CE marked valves with safety pressure release mechanism, safety Pin is of SS material, and Welding Procedure approved by TPI with 6 G certification. **Fire Class 1A:21B rating** as per IS 15683 and ISI MARK.

4.4 Fire Pumps and Allied Equipment

4.4.1 Scope

Work under this section shall consist of furnishing all labour, materials, equipment and appliances necessary and required to completely install electrically operated and diesel driven pumps and as required by drawings and specified hereinafter or given in the schedule of rates.

a. Electrically operated pumps with motors and diesel engine driven pumps with dieselengine, common base plates, coupling, coupling guard and accessories.

b. Automatic starting system with all accessories, wiring and connections and pressureswitches.

c. Motor control center.

d. Annunciation system with all accessories wiring and connections.

e. Pressure gauges with isolation valves and piping, bleed and block valves.

f. Suction strainers and accessories.

g. Vibration eliminator pads and foundation bolts.

h. Leak-off drain shall be led to the nearest floor drain.

4.4.2 General Requirements

Pumps shall be installed true to levels on suitable concrete foundations. Base plate shall be firmly fixed by properly grouted foundation bolts.

Pumps and motors shall be truly aligned by suitably instruments. Record of such alignment shall befurnished to the Project Manager.

All pump connections shall be standard flanged type with number of bolts as per relevant standardrequirement for the working pressure. Companion flanges shall be provided with

the pumps.

Manufacturers' instructions regarding installation, connections and commissioning shall be strictly followed.

Contractor shall provide necessary test certificates, type test certificates, performance curves and NPSH curves of the pumps from the manufacturer when called for. The contractor shall provide facilities to the Project Manager & Consultant for inspection of equipment during manufacturing andalso to witness various tests at the manufacturer's works without any cost to the Project Manager orConsultant.

Seismic isolation and clamping for each pump and flexible connection on the suction as well as thedischarge side shall be provided.

The contractor shall submit with this tender a list of recommended spare parts for three years of normal operation and quote the prices for the same as a separate submittal / annexure.

The contractor shall submit the network analysis & Pump head calculation with the help of standard approved software and decide optimum head for firefighting pumps for Hydrant, Sprinkler & Drencher / Water Curtain system.

4.4.3 Electric Fire Pump

General

The electric fire pump shall be suitable for automatic operation complete with necessary electric motor and automatic starting gear, suitable for operation on 415 volts, 3 phase, 50 Hz. A.C. system.Both the motor and the pump shall be assembled on a common base plate, fabricated M.S. channel type or cast iron type. The fire pump efficiency shall be in acceptable range of 65 – 70%.

Drive

The pump shall be direct driven by means of a flexible coupling. Coupling guard shall also beprovided.

4.4.3.1 Fire Pump

The fire pump shall be horizontally mounted single/ multistage, single/ multioutlet centrifugal type. It shall have a capacity to deliver__lpm as specified anddeveloping adequate head so as to ensure a minimum pressure of 3.5 Kg/Sq.cm at the highest and the farthest outlet.

The pump shall be capable of giving a discharge of not less than 150 per cent of the rated discharge, at a head of not less than 65 per cent of the rated head. The shut off head shall be within 120 per cent of the rated head.

The pump casing shall be of cast iron to grade FG 200 to IS: 210 and parts like impeller, shaft sleeve, wearing ring etc. shall be of non-corrosive metal like bronze/brass/gun metal. The shaft shall be of stainless steel. Provision of mechanical seal shall also be made.

Bearings of the pump shall be effectively sealed to prevent loss of lubricant or entry of dust or water. The pump shall be provided with a plate indicating the suction lift, delivery

head, discharge, speed and number of stages. The pump casing shall be designed to withstand 1.5 times the working pressure.

Provision of Jockey Pump for low and high zone shall be made. The pump shall be vertical SS typeand of detail as in schedule of quantity. Contractor shall verify that the capacity of the Jockey pumpshall not be less than 3% (Minimum 180 LPM) and not more than 10% of the installed pump capacity.

a. **Motor**

The motor shall be squirrel cage A.C. induction type suitable for operation on 415 volts 3 phase 50Hz. system. The motor shall be totally enclosed fan cooled type conforming to protection clause IP
55. The class of insulation shall be F. The synchronous speed shall be 1500 RPM as specified. Themotor shall be rated for continuous duty and shall have a horse power rating necessary to drive thepump at 150 per cent of its rated discharge with at least 65 per cent rated head. The motor shall conform to I.S.325-1978.

b. **Motor Starter**

The motor starter shall be as per detail in MCC. The unit shall include suitable current transformer and ammeter of suitable range on one line to indicate the current. The starter shall not incorporate under voltage, no voltage trip overload or SPP.

The starter assembly shall be suitably integrated in the power and control panel for the wet riser system & sprinkler system.

4.5. Diesel Fire Pump

General

The diesel pump set shall be suitable for automatic operation complete with necessary automatic starting gear, for starting on wet battery system and shall be complete with all accessories. Both engine and pump shall be assembled on a common base plate.

Drive

The pump shall be only direct driven by means of a flexible coupling. Coupling guard shall also beprovided. The speed shall be 1500 RPM as specified.

4.5.1 Fire Pump

The fire pump shall be horizontally mounted centrifugal single/ multi stage, single/ multi outlet. It shall have a capacity to deliver as specified and developing adequate head so as to ensure a minimum pressure of 3.5 Kg/Sq.cm at the highest and the farthest outlet. The pump shall be single/multi stage as specified. The pump shall be capable of giving a discharge of not less than 150% ofthe rated discharge at a head of not less than 65% of the rated head. The shut off head shall be within 120% of the rated head.

The pump casing shall be of cast iron to grade FG 200 to IS 210 and parts like impeller, shaft sleeves, wearing-ring etc. shall be of non-corrosive metal like bronze/brass/gun metal. The shaft shall be stainless steel. Provision of mechanical seal shall also be made.

The pump casing shall be designed to withstand 1.5 times the working pressure.

Bearing of pump shall be effectively sealed to prevent loss of lubricant or entry of dust or

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water.

4.5.2 **Diesel Engine**

Engine Rating - The engine shall be cold starting type without the necessity of preliminary heating of the engine cylinders or combustion chamber (for example, by wicks, cartridge, heater, plugs etc.). The engine shall be multi cylinder/vertical 4 stroke cycle, air-cooled, diesel engine, developing suitable HP at the operating speed specified to drive the fire pump. Continuous capacity available for the load shall be exclusive of the power requirement of auxiliaries of the diesel engine, and the after correction for altitude, ambient temperature and humidity for the specified environmental conditions. This shall be at least 20% greater than the maximum HP required to drive the pump at its duty point. It shall also be capable of driving the pump at 150% of the rated discharge at 65% ofrated head. The engine shall be capable of continuous non-stop operation for 8 hours and major overhaul shall not be required before 3000 hours of operation. The engine shall have 10% overload capacity for one hour in any period of 12 hours continuous run. The engine shall accept full load within 15 seconds from the receipt of signal to start. The diesel engine shall conform to BS 649/IS 1601/IS 10002, all amended up to date.

a. **Engine Accessories** - The engine shall be complete with the following accessories:-
Fly wheel dynamically balanced.
Direct coupling for pump and coupling guard.
Corrosion Resistor.
Air cleaner.

Fuel service tank support, and fuel oil filter with necessary pipe work.Elect. starting battery (2X24 v).
Exhaust silencer with necessary pipe work.Governor.
Instrument panel housing all the gauges, including Tachometer, hour meter and starting switchwith key (for manual starting).

Necessary safety controls.

b Fuel System - The fuel shall be gravity fed from the engine fuel tank to the engine driven fuel pump. The engine fuel tank shall be mounted either over or adjacent to the engine itself or suitably wall mounted on bracket. The fuel filter shall be suitably located to permit easy servicing.

All fuel tubing to the engine shall be with copper, with flexible hose connections where required.Plastic tubing shall not be permitted.

The fuel tank shall be of welded steel construction (3 mm. thick) and of capacity sufficient to allow the engine to run on full load for at least 4 hours. The tank shall be complete with necessary wall mounted supports, level indicator (protected against mechanical injury) inlet, outlet, overflow connections and drain plug and piping to the engine fuel tank. The outlet shall be so located as to avoid entry of any sediments into the fuel line to the engine.

As semi rotary hand pump for filling the daily service tank together with hose pipe 5 mtr. long with a foot valve etc. shall also form part of the scope of supply.

c. **Lubricating Oil System**- Forced feed Lub. Oil system shall be employed for positive lubrication. Necessary Lub. oil filters shall be provided, located suitably for convenient servicing.

d. **Starting System**- The starting system shall comprise necessary batteries (2x24v), 24 volts starter motor of adequate capacity and axle type gear to match with the toothed ring on the fly wheel. Bi metallic relay protection to protect starting motor from excessively long cranking runssuitably integrated with engine protection system shall be included within the scope of the work.

The capacity of the battery shall be suitable for meeting the needs of the starting system.

The battery capacity shall be adequate for 10 consecutive starts without recharging with coldengine under full compression.

The scope shall cover all cabling, terminals, initial charging etc.

e. **Exhaust System** - The exhaust system shall be complete with silencer suitable for outdoor installation and silencer piping including bends and accessories needed for a run of 15 metre from the engine manifold.(Adjustment rates for extra lengths shall also be given). The total backpressure shall not exceed the engine manufacture's recommendation. The exhaust piping shallbe suitably supported.

f. **Engine shut down mechanism-** This shall be auto/ manually operated and shall return automatically to the starting position after use.

g. **Governing System**- The engine shall be provided with an adjustable governor to control the engine speed within 5% of its rated speed under all conditions of load up to full load. The governor shall be set to maintain rated pump speed at maximum pump load.

h. **Engine Instrumentation**- Engine instrumentation shall include the following:-

i) Lub. oil pressure gauge.

ii) Lub. oil temperature gauge.

iii) Water pressure gauge.

iv) Water temperature gauge.

v) Tachometer.

vi) Hour meter.

The instrumentation panel shall be suitably resident mounted on the engine.

Engine Protection Devices- Following engine protection and automatic shutdown facilities shallbe provided:-

i) Low lub.oil pressure.

ii) High cooling water temp.

iii) High lub.oil temperature.

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iv) Over speed shut down.

i. **Pipe Work** - All pipe lines with fittings and accessories required shall be provided for fuel oil, lub.oil and exhaust systems, copper piping of adequate sizes, shall be used for Lub.oil and fueloil. M.S. piping will be permitted for exhaust.

j. **Anti Vibration Mounting**- Suitable vibration mounting duly approved by Project Manager shallbe employed for mounting the unit so as to minimise transmission of vibration to the structure. The isolation efficiency achievable shall be clearly indicated.

k. **Battery Charger**-Necessary float and boost charger shall be incorporated in the control sectionof the power and control panel, to keep the battery in trim condition. Voltmeter to indicate the state of charge of the batteries shall be provided.

4.6 Pump Sets Assembly

On the main fire sprinkler and hydrant headers near pump sets a 150 mm dia by-pass valve locatedin an accessible location shall be provided along with a rate of flow rota meter calibrated in 1 pm and able to read 200% of the rated pump capacity. The delivery shall be connected to the fire tank.

Each and every pump set assembly shall be provided with suction valve (only for positive suction head), discharge valve, non-return valve and 150 mm dia Bourdon type pressure gauge with isolation valve.

4.6.1 Flexible Connectors

On all suction and delivery lines double flanged reinforced neoprene flexible pipe connectors shall be provided. Connectors should be suitable for maximum working pressure of each pipe line on which it is mounted and tested to a test pressure of 1:5 time the operating pressure. Length of the connector shall be as per manufacturers standard.

4.6.2 Interlocking

The following inter-locking between the two main fire pumps (i.e. wet riser pump & sprinkler pump),the jockey pump and the diesel engine driven pump.

Only one category of pumps will work at a time i.e. either jockey pump or main fire pumps (wet riser and sprinkler, both the wet riser and sprinkler can come up at a time) or diesel driven pump.

Note: The operation logic of Fire Pumps shall be based on the below table. However the below table only provides basic logic. Contractor shall prepare detailed logic based on testing of Fire Pumps and shall commission the Fire Pump system accordingly.

	JOCKEY PUMP	HYDRANTPUMP	SPRINKLER PUMP	DIESEL DRIVEN PUMP
i.	ON	OFF	OFF	OFF
ii.	OFF	ON	OFF	OFF
iii.	OFF	OFF	ON	OFF
iv.	OFF	ON	ON	OFF
v.	OFF	OFF	ON	ON
vi.	OFF	OFF	OFF	ON
vii.	OFF	ON	OFF	ON

4.6.3 Accessories

1. Suction and discharge eccentric reducers.
2. Suction and discharge flexible
3. Suction and discharge pressure gauges 150 dia with gauge cocks brass piping forpressure damping.
4. Pump coupling guard.
5. Common base frame, fabricated M. S. or cast iron.
6. Anti –vibration mounts with a static deflection of minimum 25 mm.

Each pump including booster pump shall have independent set of pressure switches.

The pressure switches shall be snap action SPDT switch rated 10 A @ 220 V operated through a stainless steel diaphragm. The switch shall have a pointer for manual adjustment of set point, and all electrical connections shall be terminated in a screwed terminal connector and the entireunit shall be encased in a cold drawn steel enclosure. The diaphragm shall be designed for a maximum operating pressure of_____kg / cm2.

Flow switches shall be paddle type SPDT snap acting contacts rated 10A @ 220V. The paddle shall be made of either brass or phosphor bronze terminated in a screwed terminal connector and the entire unit shall be encased in a cold drawn steel enclosure. The diaphragm shall be designed for a maximum operating pressure of kg / cm2.

The motor starters (direct on – line or star – delta or auto – transformer shall consist of electrically actuated contractors in sheet steel enclosure with an indicating lamp. The starter shall be complete with ON – OFF push buttons, timbers and auxiliary contacts shall be fully

automatic. There shall be an indicating lamp with each of the pumps and an ammeter and selector switch with the fire pumps.

Auto transformers shall be korndorfer type for smooth transition and shall the floor mounting. The auto transformer shall be oil / air cooled and shall be isolated from the switch gear by providing separate chambers. The transformer shall have tapping for 40% , 60% and 75% for establishing desired torque.

The units shall be complete with ON –OFF push button, ammeter indicating lamp and automaticchangeover relays with turners etc. The under voltage protections shall be provided for fire pumps.

All electric control panels shall be sheet steel enclosed dead front type with easy access to all parts and cable terminations. The panel drawings shall be got approved before fabrication. Panels shall be fabricated out of 14 SWG 1.6 mm thick steel sheets with provisions for power – on – indication lights.

All cabling to and from the pumps to starters and control switches shall be carried out through armored PVC cables of approved makes. The entire installation shall meet with the requirementsof IS code of practice IS 732 – 1963. The pump motors and panel shall be double earthed in accordance with IS 3043 – 1966 or as shown on drawings.

4.6.4 Vibration Isolation

The pumpset shall be mounted on rolled steel channels and 150 mm thick inertia block spring and ribbed neoprene vibration isolation mounting shall support the inertia block onto a 100 mm thick concrete plinths. The spring mountings shall have a maximum deflection of 15 mm. Reference shallbe made to the section on "Nose and Vibration" for further technical requirements.

APPENDIX : LIST OF APPROVED MAKES:

1. List Of Makes – Plumbing & Fire Fighting

LIST OF APPROVED MAKES FOR EQUIPMENT & MATERIALS FOR PLUMBING SYSTEM

(As Listed Alphabetically)

Note: Contractor is free to select any of the approved makes listed herein as long as the makes comply withthe specifications and performance requirements given elsewhere in the tender document. Once proposed and approved, the Contractor shall use the same make throughout the projects.

S.No.	Details of Materials / Equipment	Manufacturer's Name
I.	**SANITARY FIXTURES AND FITTINGS** (Owner will supply Free of Cost, List of approved make given for information, however based on Architect / Client requirement sanitary/CP fittings make may vary.)	
A.	**Sanitary Fixtures:**	
1	Auto Urinal Flush System	AOS Auto Robo Flushing System AskonEngineers Euronics Toshi UTEC System
2.	Shower Tray	Duravit Kaldewei Roca
3.	Cistern	Geberit Roca Viega
4.	Low Level Flushing Cisterns	Commander Duralite
5.	Macerating systems (Sewage lifting stations)	Grundfos Sanitop
6.	Stainless Steel Sink	Kingston Prestige

		Neelkanth
		Nirali
7.	Storage Type Geyser / Heat Pump	A.O. Smith Calorex Racold Riello Venus
8.	Vitreous China Sanitaryware (W.C, Wash Basin & Urinal)	American Standard Geberit Hindware Kohler Roca

9.	Hand Dryer	Askon Engineers Blue Circle Euronics Kopal UTEC System
10.	Drinking Water Cooler / Purifier.	Blue Star Usha Voltas
11	W.C Seat Covers	Commander Champion
12	W.C Connectors	Multiwik Viega
13	Water free Urinal	Falcon Hindware
B.	**C.P Fittings**	
1.	C.P Brass Fittings	Aquaplus Grohe Jaguar Kohler Schell
2.	Flow Control Devices	Aquaplus Conserve Jaquar RST
3.	Food Crusher for Sink	Enviro Venus Zach- Rajguru
4.	Shower Channel / PP – car parkingchannel	ACO Kessel Viega
5.	Toilet Accessories	Akoi Linnet Parko
6.	Low Flow Fixtures	Geberit Roca

		Viega
7.	W.C Manual Flush valve	Geberit Roca Viega
8.	W.C Auto Flush valve	Geberit Roca Viega
II.	**COLD WATER SUPPLY**	
A.	**PIPES**	
1.	CPVC Pipes & Fittings	Ajay Ashirwad Astral George Fisher Glynwed
2.	GI / M.S Pipes (IS: 1239 and IS : 3589)	APL-Apollo Jindal Hissar Jindal Star Sail Tata Steel
3.	GI pipes fittings	Crescent Kirti Rbrand Unik Zoloto
4.	GI/MS Pipe Protection Wrapping &Coating	IWL - Pypkote Rustech – Coatek Tapen
5.	HDPE Pipe & fitting (As per IS: 4984)	Duraline Finolex Kisan Oriplas

		Reliance Geberit
6.	Stainless Steel Pipes	Jindal Reni Viega V S Metal
7.	UPVC Pipe (ASTM 1785 D)	Ajay Astral Kisan Prince
8.	Insulation for Hot Water Pipes (Elastomeric nitrile rubber / EPDM)	ALP Aeroflex Armacell Eurobatex-Union Foam K-Flex Thermaflex Trocellen Hira Industries

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B. VALVES & FITTINGS

1.	Air Vent (Release) Valve	Anergy Itap Leader Watts Zoloto
2.	Ball Float Valve	Bonomi CSA Atena Esseti Lehry Leader
3.	Non Modulating Float Valve	Singer
4.	Butterfly valve	Audco Bonomi Crane Kitz
5.	Butterfly valve with actuator	Honeywell Johnson Control Kitz L&T Schneider
6.	Cast Iron Non Return valve	Jainsons Leader Tiemme VTM Zoloto
7.	Check Valve – Wafer Type	Advance Danfoss Honeywell Intervalve Kitz
8.	Check Valve – Dual Plate	AIP Advance Econosto Honeywell Intervalve
9.	Check Valve Forged Screwed	Bonomi CIM Jainsons Lehry Zoloto
10.	FRP/GRP- SMC water tank	Binani

		Devi Polymers pvt. Ltd. Smartage Sintex
11.	Cast Iron/Cast Steel Gate Valve/SluiceValve	KirloskarLehry Sant VTM Zoloto
12.	GI pipe sealent	Henkel - Loctite 55Holdtite
13.	Globe valve	Intervalve Itap KirloskarKitz Sant Zoloto
14.	Forged Brass/Gunmetal Ball Valve	Itap Kitz LeaderSant Zoloto
15.	HDPE Tanks	Ashish Sintex
16.	Sluice Valve	Indian Valve CompanyKirloskar LehrySant Zoloto
17.	Solder Wire & Flux	IMI Yorkshire
18.	Thermostatic Mixing Valve	Danfoss OvertropSintex

19.	Temperature Sensor Gauge	Danfoss Econosto Forbes Marshall Wika
20.	Magnetic Flow meter	Emerson Krohne (Forbes Marshall) Rockwin
21.	Pressure Reducing Valve	Honeywell Itap Leader Zoloto
22.	Pressure Reducing Valve (Pilot operated)	Bonomi Leader Singer Watts
23.	Solenoid Valve	Avcon Aira Danfoss Honeywell Rapid Control
24.	Teflon Tape	Approved local
25.	Water Hammer Arrestor	Itap SKS Watts
26.	Water meter (Mechanical type)	Actaris Aquamet Bhel Capstan Kaycee
27.	Water meter (Turbine type)	Rockwin Zenner Aquamet

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III. INTERNAL DRAINAGE

A. PIPES & ACCESORIES

1.	C.P. Grating for Floor Trap	Chilly GMGRGeberitMouffleNeer Viega
2.	Channel Grating (For Utilities)	ACO GeberitKesselViega
3.	C. I. Manhole covers and frames (As per BS: 497)	NECO Raj Iron Foundry AgraSRIF
4.	D. I. Manhole covers and frames As per BS EN 124 or BS: 497)	Crescent FoundaryNECO Raj Iron Foundry, Agra
5.	D. I. Pipes (IS : 8329) and Fittings (IS :9523)	Jindal SrikalahasthiTata
6.	Floor Drain Fixture	ACO Neer GeberitViega
7.	GI / M.S Pipes (IS : 1239 & IS 3589)	APL-Apollo Jindal HissarJindal star Tata Steel
8.	UPVC Pipes (IS 13592)	Ajay AstralPrince
9.	UPVC Pipes (IS 4985) (For waste drainage 50 mm and below)	Ajay PrinceAstral
10.	Urinal Trap Neer	Chilly

11.	GI pipes fittings	Crescent Jain SonsKirti Rbrand Unik Zoloto
12.	HDPE Pipe & fitting	DuralineGeberit Kisan Reliance
13	Low noise drainage system Polypropylene (PP) Mineral reinforced	Georg Fischer-SilentaWavin

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14.	Parking Drain	ACO Kessel
15.	Prefabricated HDPE Grease Separator	ACO KesselWade
16.	Prefabricated HDPE Oil Separator	ACO KesselWade
17.	Rain water outlet	ACO GMGRGeberitNeer Viega
18.	RCC Pipe	Jain Spun Pipe Co.K K Indian Hume PipeLocal & ApprovedPranali
19.	SFRC covers/ gratings	HindustanKK
20.	Single Stack System	GeberitAstral Huliot
21.	Syphonic Roof Drainage System	Geberit George FisherNeuva TerrainSaint Gobian

B. C.I & CAST STEEL VALVES &FITTINGS (FOR DRAINAGE APPLICATION)

1.	Ball valve	Leader Sant Zoloto
2.	Butterfly valve with actuator	Belimo Econosto Honeywell Johnson ControlKitz L&T Schneider
3.	Check Valve – WaferType	Kirloskar Marck-CaireNormex
4.	Check Valve – Dual Plate	Kirloskar Marck-CaireNormex
5.	Check Valve Forged Screwed	LeaderSant Zoloto
6.	Non Return ball valve	LeaderSant Zoloto
7.	Sluice valve	Leader Sant Zoloto

IV. EXTERNAL SEWERAGE AND STORMWATER DRAINAGE

A. PIPES

1.	CI Class LA Pipes (IS : 1536)	Electro SteelIISCO Kapilansh Neco
2.	HDPE Pipe & fitting (As per IS: 14333)	DuralineKisan OriplastReliance
3.	Double wall corrugated HDPE Pipes	Alcorr D-Rex
4.	RCC pipes	K K Indian Hume PipeLocal & ApprovedPranali
5.	Stoneware Pipes & fittings including gullytrap	Anand Burn & Co. Perfect potteriesRajura

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6.	PVC-U Pipes (IS 15328)	FinolexJain Kisan Prince
B.	**ACCESSORIES**	
1.	FRP Manhole cover	Everlast Thermoset
2.	GRP Manhole cover	Everlast Thermoset
3.	Prefabrication HDPE Grease Separator	ACO KesselWade

V. CIVIL WORKS / MISCELLANEOUSITEMS

1.	C.I Manhole covers and frames (As per BS: 497)	SRIF Neco Raj Iron Foundry Agra
2.	CI Grating	SRIF Neco Raj Iron Foundry Agra
3.	D.I Grating	Crescent FoundryNeco Raj Iron Foundry, Agra
4.	D.I Manhole covers and frames	Crescent FoundryNeco Raj Iron Foundry, Agra
5.	Electronic level indicator	Auto Pump Cirrus Engineering Elegent Controls Pumptrol Technika Techtrol
6.	Foot rests	KGM Patel Pranali Industries
7.	FRP Manhole overs	Everlast Thermoset
8.	GRP Manhole overs	Everlast Thermoset
9.	Polypropylene channel	ACO

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10.	Polymer concrete drain channel	ACOMEA
11.	RCC Pipes	Indian Hume PipeK K Local & ApprovedPranali
12.	RCC Manhole covers	Local Approved

VI. PUMPS & PANEL- WATER SUPPLY &DRAINAGE

1.	Anti Vibration Mounting	Accoustics IndiaCori Dunlop Easyflex FlexionicsKanwal Resistoflex
2.	Dial type pressure gauge	EconostoEmerald Fiebig H GuruWika
3.	EPDM rubber expansion joint (Expansion Bellow)	ALP AeroflexArmacell Eurobatex – Union FoamK flex MasonVimpaWeico
4.	Hydropneumatic system / Transfer pumpsystem	Grundfos Wilo – Mather & PlattXylem Lowara Kirloskar
5.	Hydropneumatic System Integrator	BI Marketing Bangalore Dantal EngineesEmpire TubewellSevcon
6.	In-line Booster pumps	Grundfos Wilo-Mather & Platt
7.	Level Controller & Indicator (Water)	Auto Pump Cirrus Engineering Elegent Controls Pumptrol Technika Techtrol
8.	Pot Strainer	Econosto EmeraldSKS
9.	Pressure switch	Greystone Honeywell Johnson L&T ATMOSTrane
10.	Self-Priming Pumps	Armstrong CRI PumpsJohnson KSB

Kirloskar

11.	Submersible pumps- Storm water	Grundfos Wilo – Mather & PlattXylem FLYGT Kirloskar
12.	Submersible pumps- Sewage handling	Grundfos Wilo – Mather & PlattXylem FLYGT Kirloskar
13.	Y strainer	Leader LehrySant SKS Zoloto

VII. COMMON SECTION

1.	Fire Sealant & Fire Retardant paint	Birla 3 M Hilti Stanvac- Flammadur STI (USA)/ Fire masterWurth
2.	Fire Collar / Fire Stopper	HDIHilti Stanvac- FlammadurSTI
3.	Pipe Supports & Clamp	Chilly Euroclamp Easyflex Gripple Hitech
4.	Pipe Hangers	Gripple Hitech OM FastenersMupro
5.	Paints	Asian Paints BergerICI Shalimar Paints
6.	Welding Rods / Electrodes	Ador Cosmos Prima (S) Super Bond (S)
7.	Fastener	Fisher Hilti MungoPowersWurth
8.	Mildew resistant sealant, having antifungal properties	PeresealGORVIA Homey

VIII. ELECTRICAL ACCESSORIESELECTRICAL SYSTEM

1	Air Circuit Breaker (3/4 Pole)	ABB (E-MAX) Larsen & Toubro (UPOWER) Schneider Electric (MASTERPAC NW)Siemens (3WL)
2	Moulded Case Circuit Breaker (MCCB)	ABB (T-MAX) Larsen & Toubro (D-SINE) Schneider Electric (NSX SERIES)Siemens (3VL)
3	Miniature Circuit Breakers (MCB)	Hager Legrand (Lexic) Schneider Electric–(Multi9)Siemens L&TABB
4	Motor Protection Circuit Breaker(MPCB)/Starter	ABB Larsen & Toubro Schneider ElectricSiemens
5	Automatic Transfer Switch (ATS)	ASCO (300 Series/4000 series) SOCOMEC CumminsGE
6	Residual Current Circuit Breaker with Over Current Protection (RCBO)	L&T ABB Legrand Schneider Electric – (MG)Siemens Hager
7	a. Electronic Digital Meters	AE (A/V/PF/Hz/KW/KWH) with LED Display
8	Larsen & ToubroStatic Power Meter & Logger (Trivector Meters)	EL Measure Rishabh Schneider Electric(Conzerv)Siemens

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9	Potential Transformer Coated)	AE& Current Transformer (Cast Resin Epoxy Intrans Kappa PragatiInd coilPrecise
10	HRC Fuse and Fuse Fitting	SiemensL&T ABB Schneider
11	Power/Aux. Contactor	ABB Larsen & Toubro Schneider ElectricSiemens
12	Change Over Switch	HPL – SocomecLarsen & ToubroHavells Elcon
13	Indicating Lamps LED type and Push Button	Larsen & Toubro Schneider ElectricSiemens Teknik Vaishno Electricals
14	Protection Relay (Numeric Type)	ABB AREVA L & T Schneider ElectricSiemens Alstom
15	Protection Relay (Analog Type)	Siemens L & T Rishabh SchneiderAlstom ABB
16	PLC	Allen Bradley Woodward.Siemens

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		OMRON Scneider Telemecanique
17	LT cables	Gemscab KEI PolycabRPG Finolex RR Kabel
18	Cable Glands Double Compression with Comet earthing links	Dowells CosmosGripwellJainsonSMI
19	LT Jointing Kit / Termination	3M Raychem
20	PVC Glands	Control Well Lapp
21	Bi metallic Cable Lug	Comet CosmosDowells
22	PVC insulated copper conductor stranded Finolex flexible wires (FRLS)	-Polycab KEI RR CablesRPG Rajnigandha
23	Metallic / GI Conduit (ISI approved)	AKG BEC VIMCO BharatGB
24	FRLS PVC Conduit & Accessories (ISI approved)	AKG Precision DPlastBEC DiamondDuraline
25	Timer	LEGRAND(MDS) ABB L&T Schneider (Electric)SEIMENS
26	Cable Trays (Factory Fabricated) / Raceways	Indiana Profab Engineer OBO BETTERMANN Asian Ancillary Corporation

27	Cable tray supporting system	FischerAnchor Fastener Hilti
28	Fire Sealant & Fire-Retardant Paint	3 M India Ltd. HILTI Promat BTHM Engineering
29	Alarm Annunciator	Advani Oerlikon Larsen & ToubroMinilec
30	Terminal Blocks	Connect WellElmex Wago Fraser techno circuits ltd
31	Fire Survival Cables	CCI KEI PolycabRPG Finolex RR Kable
32	Cat 6 Cable & Patch Cords	Beldon Clipsal Krone Finolex PolycabD-Link
33	Motor	ABB Bharat BijleeKirloskar Siemens
34	Starter	ABB Allen BradleyKirloskar L & T SchneiderSiemens
35	Variable Frequency Drive (VFD)	ABB DanfossSiemensVACON
36	Selector Switch, Toggle switch	Kaycee Salzer (Larsen & Toubro)
37	Starter Panel and Main PHE Panel	Antelec (CPRI Approved and IEC 61439 compiled) Advance Tricolite

Note : Preference will be given to use maximum number of available components from the selected manufacturer for the project.

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LIST OF APPROVED MAKES FOR EQUIPMENT & MATERIALS

FIRE FIGHTING SYSTEM

(Listed Alphabetically)

Note: Contractor is free to select any of the approved makes listed herein as long as the makes comply with the specifications and performance requirements given elsewhere in the tender document.

Once proposed and approved, the Contractor shall use the same make throughout the project.

S.No.	Details of Materials / Equipment	Manufacturer's Name	
A.	**FIRE PUMP AND EQUIPMENT**		
2.	Fire / Sprinkler Main Pump / Jockey Pump & assembly (UL Listed, FM approved)	Armstrong Grundfos	Kirloskar Xylem (ITT)
3.	Diesel Engine	Cummins Greaves KOEL	Kirloskar Leyland
4.	Motor	ABB Kirloskar	Siemens Crompton Greaves
5	Pump flow test meter	Viking Victualic	
6.	Pressure Switch	Danfoss Infoss	Viking
7.	Foot valve	Kirloskar	Normex
8.	Y Strainer	Zoloto Lehry	Sant SKS
9.	Pot Strainer	Econosto Emerald	SKS
10.	Mechanical Seal	Burgmann	Sealol
	Butterfly valve with actuator	Belimo Econosto Honeywell Johnson Control	Kitz L&T Schneider
11.	Anti-Vibration Mounting & Flexible Connections	Cori Dunlop Easy flex	Flexionics Resistoflex

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12.	Pressure Gauge	Aquamet Emerald	Fiebig H Guru
13.	Level Controller & Indicator (Water)	Auto Pump Cirrus Engineering	Technika Techtrol

B. **FIRE HYDRANT SYSTEM ACCESSORIES**

1.	Double / Single Headed Landing Valve	Eversafe Newage Group of Co.s,Surendranagar Newage Fire Protection Engg., Mumbai Safeguard Safex Minima x
2.	Controlled pressure landing valve	Eversafe Newage Fire Protection Engg.Mumbai

3. Siamese breaching connection / Fireservice inlet draw out connection (4- Way, 3- Way & 2- Way)

Eversafe Newage Fire Protection Engg. MumbaiNewage, Group of Co.s,Surendranagar Safeguard Shah Bhogilal

4.	Fire Hose (Type A & Type B)	CRC Eversafe Jayashree Newage Fire Protection Engg., Mumbai Newage, Group of Co.s,SurendranagarSafeguard Safex
5.	Hose Box (ISI marked)	Ge etech Safelin e

6.	First Aid Hose Reel (LPCB Approved)with Hose Reel Drum	Eversafe Newage Fire Protection Engg, Mumbai Newage Group of Co.s, SurendranagarSafeguard	safe fire
7.	Branch Pipe	Eversafe Newage Fire Protection Engg, Mumbai Newage Group of Co.s, SurendranagarSafeguard Safex	
8.	Fireman Axe	Newage Minimax Safeguar d Eversafe	

C. AUTOMATICSPRINKLER SYSTEM ACCESSORIES

1.	Sprinkler Heads	Reliable Rapidrop Tyco	Victaulic Viking
2.	Water curtain nozzles	Victaulic	Viking
3.	Flexible Drop Connection (UL Listed)	Flexdrop Newage Rapidrop	Safex Tyco Victaulic
4.	Inspector's test drain assembly- UL Listed	Giacomini Rapidrop	Tyco Victualic
5.	Water Mist System	Ceasefire	Fogtech
6.	Water Flow Switch	Gem Honeywell Rapid Control	System Sensor Spray Safe Viking-Potter
7..	Tamper switch	Danfoss Honeywell Rapid Control	Infoss Viking
8.	Emergency shower and Eye wash Complying with OSHA standards	Conforming to ANSI Z358.1 and	

D. PIPES, PIPE FITTINGS, CONTROL VALVES AND MISCELLANEOUS

1.	G.I. / M.S. Pipes (IS: 1239 / IS: 3589)	Jindal Star Jindal Hissar	Tata Steel
2.	Standard M.S. Fittings	Seamless fittings	Pipeline Products
3.	Forged Steel Fittings (ASTM A 105 3000#; End connection-socket weld/threaded ASME B 16.11)	Metal Lloyds Micro Metal & AlloyFittech	Pipe Fit Rajdha nV.S
	D.I/C.I Screwed fittings	Jainsons	Merit Fire
	G.I. Fittings	Unik	Jainsons
4.	DI Grooved Fitting & Coupling	Tyco	Victaulic
5.	C.I. (Class L.A.) Pipes	Electrosteel	Kapilansh
6.	RCC Pipe	K K Pranali	Indian Hume Pipe Dhere
7.	DI MH Cover & Frame	NECO	Raj Iron Foundry, Agra
8.	FRP / GRP Manhole Covers	Everlast	Thermoset
9.	Photo Luminous Signages	Autolite	Legrand
10.	Installation Control Alarm Valve(UL Listed)	Newage Rapidrop Tyco	Viking Victaulic
11.	GM / Forged Brass Ball Valve	Danfoss Giacomini Honeywell	Lehry Zoloto
12.	Cast Iron/Cast Steel Gate Valve / Sluice Valves	Econosto Intervalve Jainsons Kirloskar	Lehry Marck-Cair Sant
13.	Butterfly Valve	Audco Danfoss Honeywell Kitz	Kirloskar Lehry Zoloto
14.	Check Valve – Wafer Type	Advance Danfoss Honeywell	Kirloskar Lehry

15.	Check Valve – Dual Plate	AIP Advance Honeywe ll Intervalv e Kirloskar	Lehry Marck-Cair Norme x Tiemm e
16.	Deluge valve	HD Fire Viking Victaulic	Priyanka FireSafex SHJD

17.	Solenoid valve	Avcon Aira	Danfoss Viking
18.	Pressure Reducing Valve (UL Listed)	HD Singer	Tyco Watts
19.	Air Release Valve	Arco CIM OR	SKS Watts
20.	Ball Float Valve	Esseti Lehry	Zoloto
21.	Couplings	Lovejoy	
22.	Spring Load Pressure Relief Valve	Honeywell Suzhik	Zoloto

E. PORTABLE FIRE EXTINGUISHERS, GASEOUS SYSTEMS AND MISCELLANEOUS

1.	AFFF Solution & Oscillating Nozzle	Ansul Newage Group of Co.s, Surendranagar Tyco Viking
2.	Electrical Panel Detection & Suppression System	Avec India Fire Detec Fire Trace Supremex
3.	Fire Extinguishers	Eversafe Minimax Safeguard cease fire Safex

F. COMMON SECTION

1..	Paints	Asian Paints Berger ICI	Shalimar Paints Johnson & Nicolas
2.	GI/MS Pipe Protection Wrapping & Coating	IWL - Pypkote Neotape	Rustech – Coatek
3.	Pipe Supports & Clamp	Chilly Euroclamp Hi-tech	Gripple Mupro
	Welding Rods / Electrodes	ADOR Cosmos	Prima(S) Super

			Bond(S)
	Fire Collar / Fire Stopper	Hilti	Stanvac-Flammadur
		HDI	
4.	Fastener	Fisher	OM
		Hilti	Powers
5.	Fire Sealant & Fire Retardant paint	Birla 3 M	Promat
		Hilti	Stanvac-Flammadur
		Powers	

G. ELECTRICAL

A. ACCESSORIES

MEDIUM VOLTAGE EQUIPMENT

1.	Power Distribution Panel and Motor Control Centre & Air Insulated Bus ducts	Adlec Control System Antia Electricals Jakson Sudhir Engineering	SPC Electrotech Sterling & Wilson Tricolite Vidyut Controls Pvt Ltd
2.	Sandwiched Construction Busduct	C&S EAE (IIGM) Godrej & Boyce L & T - Henikwon	Zucchini (Legrand)
3.	Motor	ABB Bharat Bijlee Crompton GreavesHavell Hindustan Electric Motors	Kirloskar Marathon Rotomotive Siemens
4.	Starter	ABB Allen Bradley Kirloskar	L & T Schneider Siemens
5.	Variable Frequency Drive (VFD)	ABB Alan Bradley Danfoss Fuji Electric	L&T Siemens Schneider Electric
6.	Air Circuit Breaker (3/4 Pole)	ABB (E-MAX) Larsen & Toubro (UPOWER)	Schneider Electric (MASTERPACK NW) Siemens (3WL
7.	Moulded Case Circuit Breaker(MCCB)	ABB (T-MAX) Larsen & Toubro (D-SINE)	Schneider Electric (NSXSERIES) Siemens (3VL
8.	Motor Protection Circuit Breaker(MPCB)	ABB Larsen & Toubro Schneider Electric	Siemens Siemens
9.	Automatic Transfer Switch (ATS)	ASCO Cummins	Socomec

GE Power Control

10.	Miniature Circuit Breakers (MCB)	ABB Hager Larsen & Toubro	Legrand (LEXIC) Schneider Electric (Multi9)Siemens
11.	Residual Current Circuit Breaker(RCCB)	ABB Hager Larsen & Toubro	Legrand (LEXIC) Schneider Electric (Multi9)Siemens
12.	Power/Aux. Contactor	ABB Larsen & Toubro	Schneider Electric Siemens
13.	Change Over Switch	Automatic ElectricIndcoil Kappa	Pragati Precise Intrans
14.	Control Transformer/Potential Transformers	Automatic ElectricIndcoil Kappa	Pragati Precise Intrans

15.	Current Transformer (Epoxy Cast Resin)	Automatic Electric Gilbert & Maxwell Indcoil	Kappa Matrix Pragati
16.	Electromagnetic Type	ABB Alstom Larsen & Toubro	Schneider Rishabh Siemens
17.	Indicating Lamps LED type and Push Button	Larsen & Toubro (ESBEE) Schneider Electric Siemens	Teknik Vaishno Electricals
18.	Overload relays with built in Single Phase preventer	ABB BCH Electric Ltd. GE Power Controls Larsen & Toubro	Mitsubishi Electric Schneider Electric Siemens
19.	a. Electronic Digital Meters (A/V/PF/Hz/KW/KWH) with LED Display / Duel Energy Meter / Static Meter & logger (SPML) with RS-485 port.	Automatic Electric EI Measure L & T	Rishabh Schneider Electric(Conzerv) Siemens
	b. Prepaid Meters & accessories (IS Approved)	HPL Radius Schneider Electric	Secure Socomec
	c. Electromagnetic Meters	Automatic Electric	Rishabh
20.	Power Capacitor	ABB EPCO SGE	Neptune Ducati Shreem Schneider Electric

Larsen & Toubro

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21.	Autoamtic Power Factor Correction Relay (Numeric Type)	ABB BELUK (Germany) EPCOS L&T	Neptune Ducati Power Field Power Matrix Shreem
22.	Thyristerised APFC Control Panel	ABB EPCOS Larsen & Toubro Neel Controls Neptune Ducati	Power Field Power Matrix Shreem Schneider Electric
23.	PVC insulated XLPE aluminium / copper conductor armoured MV Cables upto 1100 V grade	Finolex KEI Polycab	RPG RR Kabel Gemscab
24.	LT Jointing Kit / Termination	3M Raychem	REPL / Xicon
25.	Cable Glands Double Compression with earthing links	Comet Cosmos Dowells	Gripwell Jaison SMI
26.	Bimettalic Cable Lug	Comet Cosmos	Dowell's

27.	PVC insulated copper conductor stranded flexible wires (FRLS) -	Finole xKEI Polyca b	Rajanigandh aR R Kabel RPG
28.	Mettalic Conduit (ISI approved)	AKG BEC Bhara t	GB Vimco Suprem e
29.	PVC Conduit (ISI approved)	AKG BEC Precision	DPlast Diamon d Duraline
30.	Industrial Socket		
	Splash Proof	Clipsal ELCON - PCE Gewiss Legran d	Neptune Balls Spelseberg (Cap Electric)Scame Schneider ElectricLegrand
31.	Industrial Socket Metal Clad	BCH Hensel	
32.	Selector Switch, Toggle switch	Kaycee	Salzer (Larsen & Toubro)
33.	Timer	ABB Larsen & Toubro Legrand (MDS)	Schneider Electric Siemens
34.	LT Servo Automatic Voltage Stabilizer & Isolation Transformers	Automatic ElectricDatson Neel Controls	Numeri c Recon Servomax India Ltd.

MMRDA

35.	Inverter	Autopro (Professional Lighting)Consul Neowatt Luminous	Su-Kam Power Systems Vivtar Electronics
36.	Cable Trays (Factory Fabricated) /Raceways	Indiana OBO Bettermann Profab	Asian Ancillary CorpGripple OBO Bettermann
37.	Cable Tray Supporting System	Fischer	Hilti
38.	Fire Sealant & Fire RetardantPaint	3 M India Ltd.HILTI	Promat BTHM Engineering
39.	230/12 V Step Down Transformer with Built in Isolation Transformer	Talema	Volstat

Note : Preference will be given to use maximum number of available components from theselectedmanufacturer for the project.

MMRDA

The list below provides a list of Recommended Brands or Agencies for thematerials.

The Contractor may provide the materials of any of these brands or Equivalent.

Sr. No.	Material	Recommended Brands/ Agency		Remarks
	Floor finishing			
1	Vitrified Tiles	Kajaria / Nitco / HR Johnson / Somany		1. All materials shall beof first quality. This is particularly applicable to tiles, sanitaryware, paint.
2	Anti-skid ceramic tiles	Kajaria / Nitco / HR Johnson / Somany		2. Approved samplesshall be kept at site for comparison during procurement and installation.
3	Glazed ceramic tiles	Kajaria / Nitco / HR Johnson / Somany		3. Where specially called for warranties shall be arranged from the manufacturer in favour of the client.
4	Anti-static vitrified tiles	Armstrong / HR Johnson		4. Owner will have right to order brands other than specified in this section.
5	Vinyl flooring	Squarefoot / Polyflor / Marvel vinyl / Responsive		
6	Granite	Responsive		

MMRDA

7	Cement Tiles	Eurocon / Ultra		
8	Pavement Tiles	Eurocon / Ultra/ HR Johnson		
	Paint and Wall Finish			
9	Oil bound distemper paint	Asian / Berger / Nerolac / ICI Dulux		
10	Dry distemper			
11	Internal / External Acrylic emulsion paint	Asian / Berger / Nerolac / ICI Dulux		
12	Texture paint	Renovo / Spectrum Paint / Asian paints		
	Paint on metal surface	Asian Paint / Nerolac / Good lass Nerolac		
	Epoxy floor /wall coating	Fosroc / Sika / cipy		
	Wall care putty	Birla / JK / Duro-white / Perma		
	lse ceiling / Wall cladding			
	psum board/ Mineral Fibre board	mstrong / AMF / Saint Gobain / USG		
	minium composite panel	olic / Alucobond / Durabuild / Alucopla / Alcopanel		
	ne tile/ wall cladding	olith / Techlam / MCM Phomi / Fundermax		
	uctural Glazing / Windows / Glass partitions			
	uctural glazing glass/ Glass partitions	ahi / modi / Saint Gobin		
	minium works	Fennesta / Sai aluminium / Chiniwala		Aluminium section jindal, Hindalco

MMRDA

	minium Section	Jindal / Hindalco		
	ors and Wood works			
	Timber flush ors	Anchor / Century / Green ply / Kitply / Archidply		
	Door closer/ accessories	Dorma / Falcon / Godrej / Everest /hyper		
	or / Windows Hardware Iron mongery	Dorma / Shalimar / CIEF / Godrej		Heavy duty
	Laminates, Veneers & particle boards	Anchor / Century / Green ply / Kitply / Archidply		
	Metal doors	Shakti-met/ Guardian		
	nitary			
	nitary ware	Hindware / Parryware / Cera / Jaquar / Kohler		Brand
	Sanitary fittings / cessories	Gem / Jaquar / L & P / Parco		
	Plastic W.C. seals	Commonder / Patel		Heavy duty
	ainless steel sink	Nirali / Franke		
	C pipes & fittings	Finolex / Supreme / Prince		
	Bib Cock stop cock	Hansa / EID parry / Hindustan sanitary / Jaquar		
	G.I. Pipes 'C' Class	Zenith / Tata / Gujrat steel / Jindal / Surya / Siddharth		mark
	Stoneware pipes & fittings	Perfect / Padmanyak / Rajura / Girce		mark
	Cast iron pipes	Neco / Kesoram / Electro steel casting		

	RCC pipes	Indian hume pipe (Himalaya)		NP2 class
	G.I. / M.I. Fittings	Unik / 'R' brand/ Kranti / H.B.		mark
	Submersible pumps	KSB / Agasti / Kirloskar / ground foss		mark
	Pump set	Kirloskar/ Crompton / Beacon / KSB		
	Water meter	Capstan / Kranti		mark
	Water supply valves	Sant / Newage (Guide)		mark
	P. Flush Valve	Nelson / Jaquar		mark
	Pressure reducing valve	Zelato / HAWA / RB		
	Mirrors	Modi guard		
	her finishes			
	ater proofing	India water proofing leak proof Indialtd./ Fosroc, Penetron		
	Anti- termite atment	Pest control India		
	Polymer Based Tile adhesives	Ironite / Hardonate / Foscrock / Latecrete/ V-T. I / Bal endura		
	Polysulphide sealant	M-2 / Tuff seal / Dow / Latecrete / VTI		
	Floor dividing strips	Fixopan		

	Epoxy floor /wall coating	Fosroc / Sika / cipy		
	Wall care putty	Birla/JK/Duro-white/perma		
	White cement	Birla, J.K., Grassim		
	C / structural steel and tensile fabric			
	Ready mix concrete	Birla (Grassim) L & T Godrej		
	Reinforcement steel Fe 415 TMT / Fe 500 TMT	TISCO / SAIL / Ispat / Essar/RINL		
	Cement 43 grade / 53 gr.	ACC, Gujrat Ambuja, Vasavdatta, Ultra tech, Grassim		
	Steel Truss			per IS 875
	Tensile Fabric Membrane	Ferrari / Mehler		

Annexure FF-01

FIRE FIGHTING WATER CONSUMPTIOM DATA - SUMMARY -

SL. NO.	DESCRIPTION	UG TANK CU.M./ DAY	OH TANK CU.M./ DAY
1	FOR MAIN ADMINISTRATION & COMMAND CONTROL CENTERBUILDING AT MAIN TOLL PLAZA, CHIRLE, NAVI MUMBAI	100	10
2	FOR ADMINISTRATION BUILDING AT INTERCHANGE	Not Required /Not Applicable	10

3	FOR ADMINISTRATION BUILDING AT SHIVAJINAGAR INTERCHANGE, NEAR / NEXT TO RAMP AC	Not Required /Not Applicable	10
4	FOR ADMINISTRATION BUILDING AT SHIVAJINAGAR INTERCHANGE, NEAR / NEXT TO RAMP AM	Not Required /Not Applicable	10
5	FOR ADMINISTRATION BUILDING AT SHIVAJINAGAR INTERCHANGE, NEAR / NEXT TO RAMP CA	Not Required /Not Applicable	10
6	FOR ADMINISTRATION BUILDING AT SHIVAJINAGAR INTERCHANGE, NEAR / NEXT TO RAMP MA	Not Required /Not Applicable	10
7	FOR ADMINISTRATION BUILDING AT SHIVAJINAGAR INTERCHANGE, NEAR / NEXT TO RAMP MJ	Not Required /Not Applicable	10
8	FOR ADMINISTRATION BUILDING AT SHIVAJINAGAR INTERCHANGE, NEAR / NEXT TO RAMP JM	Not Required /Not Applicable	10
9	FOR SUB ADMINISTRATION & COMMAND CONTROL CENTERBUILDING AT SEWRI INTERCHANGE, MUMBAI	50	5

Note : The above table has indicative numbers and It shall be Mandatory for the Package 4 Contractor to design and calculate the capacities as per NBC 2016 and determine the necessary sizes of the Water Tanks / Static and Dynamic Equipment / Pumps / Pipes and Fittings / etc;

Annexure FF-01 / 01

FOR MAIN ADMINISTRATION & COMMAND CONTROL CENTER BUILDING AT MAIN TOLL PLAZA, CHIRLE, NAVI MUMBAI

Building Total Height 20.95M

Sr. No.	Description	Minimum Requirements for Fire Fighting Installation as per NBC 2016 - Part 4 Fire & Life Safety (Table 7)
1	Type of Building Occupancy	Business Building (E-3) Above 15M & upto 24M in Height
2	Fire Extinguisher	Required
3	First Aid Hose Reel	Required
4	Wet Riser	Required
5	Down Comer	Not Required
6	Yard Hydrant	Required
7	Automatic Sprinkler System	Required
8	Manually Operated Electronic Fire Alarm System	Required
9	Automatic Detection & Alarm System	Required
10	Under-ground Static Water Storage Tank Combined Capacity for Wet Riser, Yard Hydrant and Sprinklers per Set of Pumps	1,00,000 Litres for Per Set of Pumps - For Each Building
11	Terrace Tank over Respective Tower Terrace	10,000 Litres - For Each Building
12	Pump Near Underground Static Water Storage Tank (Fire Pump) with Minimum Pressure of 3.5 kg/cm² at the	1 Electrical Main Pump of 2280LPM Capacity, 1 Diesel Standby Pump of 2280LPM Capacity and 1 Electrical Jockey Pump of 180LPM Capacity

MMRDA

	Remotest Location	(Please Refer Note: 10 along with Note: 22 & Note: 23 in the Work Sheet NBC 2016 - Part 4)
13	At the Terrace Tank Level with Minimum Pressure of 3.5 kg/cm^2	1 Electrical Pump of 450LPM Capacity
For Toll Cabins / Booths & surronding Areas; Appropriate No. of Fire Extinguishers along with Sand Buckets will be Provided.		

Note : The above table has indicative numbers and It shall be Mandatory for the Package 4 Contractor to design and calculate the capacities as per NBC 2016 and determine the necessary sizes of the Water Tanks / Static and Dynamic Equipment / Pumps / Pipes and Fittings / etc;

Annexure FF-01 / 02

FOR ADMINISTRATION BUILDING AT INTERCHANGE

Building Total Height 9.85M

Sr. No.	Description	Minimum Requirements for Fire Fighting Installation as per NBC 2016 - Part 4 Fire & Life Safety (Table 7)
1	Type of Building Occupancy	Business Building (E-1) Less than 10M in Height
2	Fire Extinguisher	Required
3	First Aid Hose Reel	Required
4	Wet Riser	Not Required
5	Down Comer	Required
6	Yard Hydrant	Not Required
7	Automatic Sprinkler System	Required (Please Refer Note: 4 in the Work Sheet NBC 2016 - Part 4)
8	Manually Operated Electronic Fire Alarm System	Required
9	Automatic Detection & Alarm System	Not Required
10	Under-ground Static Water Storage Tank Combined Capacity for Wet Riser, Yard Hydrant and Sprinklers per Set of Pumps	Not Required
11	Terrace Tank over Respective Tower Terrace	10,000 Litres - For Each Building (Please Refer Note: 6 in the Work Sheet NBC 2016 - Part 4)

MMRDA

12	Pump Near Underground Static Water Storage Tank (Fire Pump) with Minimum Pressure of 3.5 kg/cm² at the Remotest Location	Not Required
13	At the Terrace Tank Level with Minimum Pressure of 3.5 kg/cm²	1 Electrical Pump of 450LPM Capacity (Please Refer Note: 6 in the Work Sheet NBC 2016 - Part 4)
For Toll Cabins / Booths & surronding Areas; Appropriate No. of Fire Extinguishers along with Sand Buckets will be Provided.		

Note : The above table has indicative numbers and It shall be Mandatory for the Package 4 Contractor to design and calculate the capacities as per NBC 2016 and determine the necessary sizes of the Water Tanks / Static and Dynamic Equipment / Pumps / Pipes and Fittings / etc;

Annexure

FF-01 / 03 FOR ADMINISTRATION BUILDING AT SHIVAJINAGAR INTERCHANGE, NEAR / NEXT TO ALL RAMPS (APPLICABLE FOR EACH ADMINISTRATION BUILDING)

Building Total Height 6.95M

Sr. No.	Description	Minimum Requirements for Fire Fighting Installation as per NBC 2016 - Part 4 Fire & Life Safety (Table 7)
1	Type of Building Occupancy	Business Building (E-1) Less than 10M in Height
2	Fire Extinguisher	Required
3	First Aid Hose Reel	Required
4	Wet Riser	Not Required
5	Down Comer	Required
6	Yard Hydrant	Not Required
7	Automatic Sprinkler System	Required (Please Refer Note: 4 in the Work Sheet NBC 2016 - Part 4)
8	Manually Operated Electronic Fire Alarm System	Required
9	Automatic Detection & Alarm System	Not Required
10	Under-ground Static Water Storage Tank Combined Capacity for Wet Riser, Yard Hydrant and Sprinklers per Set of Pumps	Not Required
11	Terrace Tank over Respective Tower Terrace	10,000 Litres - For Each Building (Please Refer Note: 6 in the Work Sheet NBC 2016 - Part 4)

MMRDA

12	Pump Near Underground Static Water Storage Tank (Fire Pump) with Minimum Pressure of 3.5 kg/cm^2 at the Remotest Location	Not Required
13	At the Terrace Tank Level with Minimum Pressure of 3.5 kg/cm^2	1 Electrical Pump of 450LPM Capacity (Please Refer Note: 6 in the Work Sheet NBC 2016 - Part 4)
For Toll Cabins / Booths & surronding Areas; Appropriate No. of Fire Extinguishers along with Sand Buckets will be Provided.		

Note : The above table has indicative numbers and It shall be Mandatory for the Package 4 Contractor to design and calculate the capacities as per NBC 2016 & determine the necessary sizes of the Water Tanks / Static and Dynamic Equipment / Pumps / Pipes and Fittings / etc;

Annexure FF-01 / 04 FOR SUB ADMINISTRATION & COMMAND CONTROL CENTER BUILDING AT SEWRI INTERCHANGE, MUMBAI
Building Total Height 13.35M

Sr. No.	Description	Minimum Requirements for Fire Fighting Installation asper NBC 2016 - Part 4 Fire & Life Safety (Table 7)
1	Type of Building Occupancy	Business Building (E-2) Above 10M but not exceeding 15M in Height
2	Fire Extinguisher	Required
3	First Aid Hose Reel	Required
4	Wet Riser	Required
5	Down Comer	Not Required
6	Yard Hydrant	Not Required
7	Automatic Sprinkler System	Required (Please Refer Note: 4 in the Work Sheet NBC 2016 - Part 4)
8	Manually Operated Electronic Fire Alarm System	Required
9	Automatic Detection & Alarm System	Required
10	Under-ground Static Water Storage Tank Combined Capacity for Wet Riser, Yard Hydrant and Sprinklers per Set of Pumps	50,000 Litres for Per Set of Pumps - For Each Building
11	Terrace Tank over Respective Tower Terrace	5,000 Litres For Each Building (Please Refer Note: 6 in the Work Sheet NBC 2016 - Part 4)

12	Pump Near Underground Static Water Storage Tank (Fire Pump) with Minimum Pressure of 3.5 kg/cm^2 at the Remotest Location	1 Electrical Main Pump of 1620LPM Capacity, 1 Diesel Standby Pump of 1620LPM Capacity and 1 Electrical Jockey Pump of 180LPM Capacity (Please Refer Note: 14 along with Note: 22 & Note: 23 in the Work Sheet NBC 2016 - Part 4)
13	At the Terrace Tank Level with Minimum Pressure of 3.5 kg/cm 2	1 Electrical Pump of 450LPM Capacity (Please Refer Note: 6 in the Work Sheet NBC 2016 - Part 4)

Note : The above table has indicative numbers and It shall be Mandatory for the Package 4 Contractor to design and calculate the capacities as per NBC 2016 and determine the necessary sizes of the Water Tanks / Static and Dynamic Equipment / Pumps / Pipes and Fittings / etc;

Annexure PHE-

PLUMBING WATER CONSUMPTIOM DATA - SUMMARY

SL. NO.	DESCRIPTION	UG TANK		OH TANK	
		DOMESTIC	FLUSHING + IRRIGATION	DOMESTIC	FLUSHING + IRRIGATION
		CU.M./ DAY		CU.M./ DAY	
1	FOR MAIN ADMINISTRATION & COMMAND CONTROL CENTER BUILDING AT MAIN TOLL PLAZA, CHIRLE, NAVI MUMBAI	4	24	2	12
2	FOR ADMINISTRATION BUILDING AT INTERCHANGE	2	12	2	6
3	FOR ADMINISTRATION BUILDING AT SHIVAJINAGAR INTERCHANGE, NEAR / NEXT TO RAMP AC	2	6	2	3
4	FOR ADMINISTRATION BUILDING AT SHIVAJINAGAR INTERCHANGE, NEAR / NEXT TO RAMP AM	2	6	2	3
5	FOR ADMINISTRATION BUILDING AT SHIVAJINAGAR INTERCHANGE, NEAR / NEXT TO RAMP CA	2	6	2	3
6	FOR ADMINISTRATION BUILDING AT SHIVAJINAGAR INTERCHANGE, NEAR / NEXT TO RAMP MA	2	6	2	3
7	FOR ADMINISTRATION BUILDING AT SHIVAJINAGAR INTERCHANGE, NEAR / NEXT TO RAMP MJ	2	6	2	3

8	FOR ADMINISTRATION BUILDING AT SHIVAJINAGAR INTERCHANGE, NEAR / NEXT TO RAMP JM	2	6	2	3	ERG-347
9	FOR SUB ADMINISTRATION & COMMAND CONTROL CENTER BUILDING AT SEWRI INTERCHANGE, MUMBAI	2	12	2	6	

Note : The above table has indicative numbers and It shall be Mandatory for the Package 4 Contractor to design and calculate the capacities as per NBC 2016 and determine the necessary sizes of the Water Tanks / Static and Dynamic Equipment / Pumps / Pipes and Fittings / etc;

Annexure PHE-01-01

WATER CONSUMPTIOM DATA	DESIGN DATA BASIS
FOR MAIN ADMINISTRATION & COMMAND CONTROL CENTER BUILDING AT MAIN TOLL PLAZA, CHIRLE, NAVI MUMBAI	

SL. NO.	DESCRIPTION	POPULATION PER UNIT	TOTAL POPULATION (APPROX)	COLD WATER REQUIREMENT				GROSS WATER REQUIREMENT (A+B)	%AGE FLOW TO SEWER				
				DOMESTIC (A)		FLUSHING (B)			DOMESTIC		FLUSHING		TOTAL
				LPCD	LPD	LPCD	LPD	LPD	%	LPD	%	LPD	LPD
a	OFFICE STAFF - FIXED POPULATION	–	137	25	3426	20	2741	6166	85	2912	100	2741	5652
b	GENERAL / OTHER SUPPORT STAFF POPULATION [HOUSE KEEPING + SECURITY + MAINTENANCE]	–	14	25	343	20	274	617	85	291	100	274	565
c	VISITOR POPULATION	–	14	5	69	10	137	206	85	58	100	137	195
d	FOR IRRIGATION / LANDSCAPE	–					21000	21000					

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	AREA											
	TOTAL		3837		24152	27988		3261		3152		6413
	TOTAL (ROUNDING OFF TO NEAREST) (CU.M/DAY)		3.8		24.2	28.0		3.3		3.2		6.4
4					24	28		4		4		8

LPD: Litres Per Day
LPCD: Litres Per Capita Per Day

A. General / Other Support Staff Population - Assumed / Considered 10% of Fixed Population.

B. Visitor Population - Assumed / Considred 10% of Fixed Popuation.

C. Irrigation / Landscape Area - Assumed / Considerd 3000 Sq.M.

D. Gross Water Demand For Office Staff - Fixed Population = 45 Lits / Person / Day; as per NBC 2016 - Part 9 Plumbing Services (Including Solid Waste Management) - Section 1 Water Supply - Table 1.

1. Net Water Demand For Domestic Use = 25 Lits / Person / Day.
2. Net Water Demand For Flushing Use = 20 Lits / Person / Day.

E. Gross Water Demand For General / Other Support Staff Population = 45 Lits / Person / Day; as per NBC 2016 - Part 9 Plumbing Services (Including Solid Waste Management) - Section 1 Water Supply - Table 1.

1. Net Water Demand For Domestic Use = 25 Lits / Person / Day.
2. Net Water Demand For Flushing Use = 20 Lits / Person / Day.

F. Gross Water Demand For Visitor Population = 15 Lits / Person / Day; as per NBC 2016 –

G. Part 9 Plumbing Services (Including Solid Waste Management) - Section 1.

1. Net Water Demand For Domestic Use = 5 Lits / Person / Day.
2. Net Water Demand For Flushing Use = 10 Lits / Person / Day.

H. Gross Water Demand for Irrigation / Landscape Area 7 Lits/Sq.M.

Note : The above table has indicative numbers and It shall be Mandatory for the Package 4 Contractor to design and calculate the capacities as per NBC 2016 and determine the necessary sizes of the Water Tanks / Static and Dynamic Equipment / Pumps / Pipes and Fittings / etc;

Annexure PHE-01-02

WATER CONSUMPTIOM DATA	DESIGN DATA BASIS
FOR ADMINISTRATION BUILDING AT INTERCHANGE	

SL. NO.	DESCRIPTION	POPULATION PER UNIT	TOTAL POPULATION (APPROX)	COLD WATER REQUIREMENT				GROSS WATER REQUIREMENT (A+B)	%AGE FLOW TO SEWER				
				DOMESTIC(A)		FLUSHING(B)			DOMESTIC		FLUSHING		TOTAL
				LPCD	LPD	LPCD	LPD	LPD	%	LPD	%	LPD	LPD
a	OFFICE STAFF - FIXED POPULATION	–	21	25	528	20	422	950	85	449	100	422	871
b	GENERAL / OTHER SUPPORT STAFF POPULATION [HOUSE KEEPING + SECURITY + MAINTENANCE]	–	2	25	53	20	42	95	85	45	100	42	87
c	VISITOR POPULATION	–	2	5	11	10	21	32	85	9	100	21	30
d	FOR IRRIGATION / LANDSCAPE AREA	–					10500	10500					

TOTAL		591		10986	11577		503	486	988
TOTAL (ROUNDING OFF TO NEAREST) (CU.M/DAY)		0.6		11.0	11.6		0.5	0.5	1.0
		2		12	14		2	2	4

LPD: Litres Per Day
LPCD: Litres Per Capita Per Day

A. General / Other Support Staff Population - Assumed / Considered 10% of Fixed Population.

B. Visitor Population - Assumed / Considred 10% of Fixed Popuation.

C. Irrigation / Landscape Area - Assumed / Considerd 1500 Sq.M.

D. Gross Water Demand For Office Staff - Fixed Population = 45 Lits / Person / Day; as per NBC 2016 - Part 9 Plumbing Services (Including Solid Waste Management) - Section 1 Water Supply - Table 1.

1. Net Water Demand For Domestic Use = 25 Lits / Person / Day.
2. Net Water Demand For Flushing Use = 20 Lits / Person / Day.

E. Gross Water Demand For General / Other Support Staff Population = 45 Lits / Person / Day; as per NBC 2016 - Part 9 Plumbing Services (Including Solid Waste Management) - Section 1 Water Supply - Table 1.

1. Net Water Demand For Domestic Use = 25 Lits / Person / Day.
2. Net Water Demand For Flushing Use = 20 Lits / Person / Day.

F. Gross Water Demand For Visitor Population = 15 Lits / Person / Day; as per NBC 2016 - Part 9 Plumbing Services (Including Solid Waste Management) - Section 1.

1. Net Water Demand For Domestic Use = 5 Lits / Person / Day.
2. Net Water Demand For Flushing Use = 10 Lits / Person / Day.

H. Gross Water Demand for Irrigation / Landscape Area 7 Lits/Sq.M.

Note : The above table has indicative numbers and It shall be Mandatory for the Package 4 Contractor to design and calculate the capacities as per NBC 2016 and determine the necessary sizes of the Water Tanks / Static and Dynamic Equipment / Pumps / Pipes and Fittings / etc;

Annexure PHE-01-03

WATER CONSUMPTIOM DATA	DESIGN DATA BASIS

FOR ADMINISTRATION BUILDING AT SHIVAJINAGAR INTERCHANGE, NEAR / NEXT TO RAMP AC, AM, CA, MA, MJ & JM (APPLICABLE FOR EACH ADMINISTRATION BUILDING)

SL. NO.	DESCRIPTION	POPULATION PER UNIT	TOTAL POPULATION (APPROX)	COLD WATER REQUIREMENT				GROSS WATER REQUIREMENT (A+B)	%AGE FLOW TO SEWER				
				DOMESTIC (A)		FLUSHING(B)			DOMESTIC		FLUSHING		TOTAL
				LPCD	LPD	LPCD	LPD	LPD	%	LPD	%	LPD	LPD
a	OFFICE STAFF - FIXED POPULATION	–	6	25	155	20	124	279	85	132	100	124	256
b	GENERAL / OTHER SUPPORT STAFF POPULATION [HOUSE KEEPING + SECURITY + MAINTENANCE]	–	1	25	15	20	12	28	85	13	100	12	26
c	VISITOR POPULATION	–	1	5	3	10	6	9	85	3	100	6	9
d	FOR IRRIGATION / LANDSCAPE AREA	–					5250	5250					
TOTAL					17		53	5566		14		14	29

		4		93			8	3	0
TOTAL (ROUNDING OFF TO NEAREST) (CU.M/DAY)		0.2		5.4	5.6		0.1	0.1	0.3
2				6	8		2	2	4

LPD: Litres Per Day
LPCD: Litres Per Capita Per Day

A. General / Other Support Staff Population - Assumed / Considered 10% of Fixed Population.

B. Visitor Population - Assumed / Considred 10% of Fixed Popuation.

C. Irrigation / Landscape Area - Assumed / Considerd 750 Sq.M.

D. Gross Water Demand For Office Staff - Fixed Population = 45 Lits / Person / Day; as per NBC 2016 - Part 9 Plumbing Services (Including Solid Waste Management) - Section 1 Water Supply - Table 1.

1. Net Water Demand For Domestic Use = 25 Lits / Person / Day.
2. Net Water Demand For Flushing Use = 20 Lits / Person / Day.

E. Gross Water Demand For General / Other Support Staff Population = 45 Lits / Person / Day; as per NBC 2016 - Part 9 Plumbing Services (Including Solid Waste Management) - Section 1 Water Supply - Table 1.

1. Net Water Demand For Domestic Use = 25 Lits / Person / Day.
2. Net Water Demand For Flushing Use = 20 Lits / Person / Day.

F. Gross Water Demand For Visitor Population = 15 Lits / Person / Day; as per NBC 2016 - Part 9 Plumbing Services (Including Solid Waste Management) - Section 1.

1. Net Water Demand For Domestic Use = 5 Lits / Person / Day.
2. Net Water Demand For Flushing Use = 10 Lits / Person / Day.

H. Gross Water Demand for Irrigation / Landscape Area 7 Lits/Sq.M.

Note : The above table has indicative numbers and It shall be Mandatory for the Package 4 Contractor to design and calculate the capacities as per NBC 2016 and determine the necessary sizes of the Water Tanks / Static and Dynamic Equipment / Pumps / Pipes and Fittings / etc;

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Annexure PHE-01-04

WATER CONSUMPTIOM DATA	DESIGN DATA BASIS

FOR SUB ADMINISTRATION & COMMAND CONTROL CENTER BUILDING AT SEWRI INTERCHANGE, MUMBAI

SL. NO.	DESCRIPTION	POPULATION PER UNIT	TOTAL POPULATION (APPROX)	COLD WATER REQUIREMENT				GROSS WATER REQUIREMENT (A+B)	%AGE FLOW TO SEWER				
				DOMESTIC (A)		FLUSHING (B)			DOMESTIC		FLUSHING		TOTAL
				LPCD	LPD	LPCD	LPD	LPD	%	LPD	%	LPD	LPD
a	OFFICE STAFF - FIXED POPULATION	–	36	25	890	20	712	1602	85	757	100	712	1469
b	GENERAL / OTHER SUPPORT STAFF POPULATION [HOUSE KEEPING + SECURITY + MAINTENANCE]	–	4	25	89	20	71	160	85	76	100	71	147
c	VISITOR POPULATION	–	4	5	18	10	36	53	85	15	100	36	51
d	FOR IRRIGATION / LANDSCAPE AREA	–					10500	10500					
TOTAL					997		11319	12316		847		819	1666

TOTAL (ROUNDING OFF TO NEAREST) (CU.M/DAY)		1.0		11.3	12.3		0.8		0.8	1.7	
2				12	14		2		2	4	

LPD: Litres Per Day
LPCD: Litres Per Capita Per Day

A. General / Other Support Staff Population - Assumed / Considered 10% of Fixed Population.

B. Visitor Population - Assumed / Considred 10% of Fixed Popuation.

C. Irrigation / Landscape Area - Assumed / Considerd 1500 Sq.M.

D. Gross Water Demand For Office Staff - Fixed Population = 45 Lits / Person / Day; as per NBC 2016 - Part 9 Plumbing Services (Including Solid Waste Management) - Section 1 Water Supply - Table 1.

1. Net Water Demand For Domestic Use = 25 Lits / Person / Day.
2. Net Water Demand For Flushing Use = 20 Lits / Person / Day.

E. Gross Water Demand For General / Other Support Staff Population = 45 Lits / Person / Day; as per NBC 2016 - Part 9 Plumbing Services (Including Solid Waste Management) - Section 1 Water Supply - Table 1.

1. Net Water Demand For Domestic Use = 25 Lits / Person / Day.
2. Net Water Demand For Flushing Use = 20 Lits / Person / Day.

F. Gross Water Demand For Visitor Population = 15 Lits / Person / Day; as per NBC 2016 - Part 9 Plumbing Services (Including Solid Waste Management) - Section 1.

1. Net Water Demand For Domestic Use = 5 Lits / Person / Day.
2. Net Water Demand For Flushing Use = 10 Lits / Person / Day.

H. Gross Water Demand for Irrigation / Landscape Area 7 Lits/Sq.M.

Note : The above table has indicative numbers and It shall be Mandatory for the Package 4 Contractor to design and calculate the capacities as per NBC 2016 and determine the necessary sizes ofthe Water Tanks / Static and Dynamic Equipment / Pumps / Pipes and Fittings / etc;

Annexure PHE-02/01

FOR MAIN ADMINISTRATION & COMMAND CONTROL CENTER BUILDING AT MAIN TOLL PLAZA, CHIRLE, NAVI MUMBAI

Average Rate / Intensity of Rainfall Considred 125 MM/Hr (Approx.)

मुंबई महानगर प्रदेश विकास प्राधिकरण MMRDA MUMBAI METROPOLITAN REGION DEVELOPMENT AUTHORITY

As per NBC 2016 - Part 9 Plumbing Services (Including Solid Waste Management) -Section 2 Drainage & Sanitation - Table 23.

For Area		67.20	Sq.M.
100 MM Diameter Pipe		1.00	No.
Main Admin Building Terrace Area		1210.90	Sq.M
100 MM Diameter Pipe Required		18.02	Nos.
	Say	18.00	Nos.
Toll Cabins / Booths Overall Roof Area		431.41	Sq.M
100 MM Diameter Pipe Required		6.42	Nos.
	Say	7.00	Nos.

Note : The above table has indicative numbers and It shall be Mandatory for the Package 4 Contractor to design and calculate the capacities as per NBC 2016and determine the necessary sizes of the Water Tanks / Static and Dynamic Equipment / Pumps / Pipes and Fittings / etc;

MMRDA

Annexure PHE-02/02

FOR ADMINISTRATION BUILDING AT INTERCHANGE

Average Rate / Intensity of Rainfall Considred 125 MM/Hr (Approx.)

As per NBC 2016 - Part 9 Plumbing Services (Including Solid Waste Management) -Section 2 Drainage & Sanitation - Table 23.

For Area		67.20	Sq.M.
100 MM Diameter Pipe		1.00	No.
Admin Building Terrace Area 1		227.39	Sq.M
100 MM Diameter Pipe Required		3.38	Nos.
	Say	4.00	Nos.
Admin Building Terrace Area 2		74.52	Sq.M
100 MM Diameter Pipe Required		1.11	Nos.
	Say	2.00	Nos.
Admin Building Terrace Area 3		74.52	Sq.M
100 MM Diameter Pipe Required		1.11	Nos.
	Say	2.00	Nos.
Toll Cabins / Booths Overall Roof Area		168.15	Sq.M.
100 MM Diameter Pipe Required		2.50	Nos.
	Say	3.00	Nos.

Note : The above table has indicative numbers and It shall be Mandatory for the Package 4 Contractor to design and calculate the capacities as per NBC 2016 anddetermine the necessary sizes of the Water Tanks / Static and Dynamic Equipment / Pumps / Pipes and Fittings / etc;

Annexure PHE-02/04

FOR SUB ADMINISTRATION & COMMAND CONTROL CENTER BUILDING AT SEWRIINTERCHANGE, MUMBAI

Average Rate / Intensity of Rainfall Considred 125 MM/Hr (Approx.)

As per NBC 2016 - Part 9 Plumbing Services (Including Solid Waste Management) -Section 2 Drainage & Sanitation - Table 23.

For Area		67.20	Sq.M
100 MM Diameter Pipe		1.00	No.
Sub Admin Building Terrace Area 1		263.0 5	Sq. M
100 MM Diameter Pipe Required		3.91	Nos.
	Say	4.00	Nos.
Sub Admin Building Terrace Area 2		56.81	Sq. M
100 MM Diameter Pipe Required		0.85	Nos.
	Say	1.00	Nos.
Sub Admin Building Terrace Area 3		56.81	Sq. M
100 MM Diameter Pipe Required		0.85	Nos.
	Say	1.00	Nos.

Note : The above table has indicative numbers and It shall be Mandatory for the Package 4 Contractor to design and calculate the capacities as per NBC 2016 and determine the necessary sizes of the Water Tanks / Static and Dynamic Equipment / Pumps / Pipes and Fittings / etc;

MMRDA

Annexure PHE-02/03

FOR ADMINISTRATION BUILDING AT SHIVAJINAGAR INTERCHANGE, NEAR / NEXTTO RAMP AC, AM, CA, MA, MJ & JM

Average Rate / Intensity of Rainfall Considred 125 MM/Hr (Approx.)

As per NBC 2016 - Part 9 Plumbing Services (Including Solid Waste Management) -Section 2 Drainage & Sanitation - Table 23.

For Area		67.20	Sq.M.
100 MM Diameter Pipe		1.00	No.
Admin Building Terrace Area		105.4	Sq.M
		8	.
(Applicable for Each Administration Building)			
100 MM Diameter Pipe Required		1.57	Nos.
Say		2.00	Nos.
Toll Cabins / Booths Overall Roof Area		168.1	Sq.M
		5	.
(Applicable for Toll Cabins / Booths Near / Next to Ramp AC / CA / JM)			
100 MM Diameter Pipe Required		2.50	Nos.
	Say	3.00	Nos.
Toll Cabins / Booths Overall Roof Area		326.5	Sq.M
		2	.
(Applicable for Toll Cabins / Booths Near / Next to Ramp AM)			
100 MM Diameter Pipe Required		4.86	Nos.
	Say	5.00	Nos.
Toll Cabins / Booths Overall Roof Area		220.9	Sq.M
		4	.
(Applicable for Toll Cabins / Booths Near / Next to Ramp MA)			
100 MM Diameter Pipe Required		3.29	Nos.
	Say	4.00	Nos.

Note : The above table has indicative numbers and It shall be Mandatory for the Package 4 Contractor to design and calculate the capacities as per NBC 2016and determine the necessary sizes of the Water Tanks / Static and Dynamic Equipment / Pumps / Pipes and Fittings / etc;