BRIHANMUMBAI MUNICIPAL CORPORATION
MUMBAI SEWAGE DISPOSAL PROJECT
STAGE – II PRIORITY WORKS

UPGRADATION OF GHATKOPAR INFLUENT PUMPING STATION & CARRYING CAPACITY OF RISING MAIN TO DESIGN PFF CAPACITY OF 699 MLD

VOLUME - III

TECHNICAL SPECIFICATIONS AND CONTRACT FORMS

OCTOBER 2022

EMPLOYER

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Municipal Head Office Building,
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CONSULTANT

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CIVIL TECHNICAL SPECIFICATIONS

INDEX

SECTION 01000 GENERAL REQUIREMENTS

PART 1 - GENERAL

1.01 Reference:

A. These Specifications form an integral Division of the Contract Documents.

B. Refer also to all other parts of the Contract Documents to determine their effect on the work of each Division of these Specifications.

C. The requirements of this Division 1 apply to and govern the work under other Divisions – Division 2 to Division 16 and their sections.

D. All instructions, unless otherwise indicated are addressed to the Contractor and included in the scope of work.

E. For definitions refer to the Conditions of Contract.

PART 2 - PRODUCTS

2.01 Products:

A. There are no Products in this Section.

PART 3 - EXECUTION

3.01 Mobilization and Demobilization:

A. Supply and erect signs, barricades, flashers, delineators, and provide flag persons, and such other protection as may be required to protect the public during construction.

B. Provide temporary fence to define Contractor's working area when working adjacent to another Contractor / adjacent to existing plant.

C. Provide security protection for Contractor's/ Engineer's office, plant and stored materials.

D. Move onto site and set up Contractor's & Engineer's office, storage facilities, and plant including sanitary facilities, temporary fencing, water, electricity and telephone.

E. Provide necessary access to the project including haul roads as required and restoration of surfaces to original condition after haul roads are removed.

F. Use locally available materials to reduce emissions due to transportation. Ensure that at least 10% of civil construction materials by value, such as concrete, steel, tiles, glass etc are sourced within a radius of 400km from project site.

G. Remove temporary Contractor's & Engineer's office, temporary storage facilities and other temporary work after completing the work and leave site clean and tidy.

3.02 Examination:

A. Examine the site and any work on which the work of each Division depends. Check all dimensions and if any discrepancies or defects are found, notify the Engineer.

B. Before commencing work obtain from BMC a list of designated substances on site in accordance with Public Health Safety Act and Regulations and other utility requirements.

C. Thoroughly examine the site and confirm the location of designated substances before commencing work.

D. Inform workers and sub-contractors of the locations of designated substances on site before commencing work.

E. Commencement of the work implies acceptance by the Contractor of dimensions, conditions and surfaces.

3.03 Work to Conform:

A. During design, ensure that future expansion of the facility can be accommodated with a minimum cost and environmental impact and with minimum disruption to the pumping facility.

B. During construction and upon completion, ensure that all work conforms to the Contract during its progress and on its completion, true to the lines, levels and grades shown on the approved by BMC during detailed engineering. Ensure that the work is built in a thoroughly substantial and workmanlike manner, in accordance with the Drawings and Specifications, subject to such modifications and additions as may be deemed necessary by the Engineer.

C. Confirm to applicable codes and standards including, but not limited to, those listed in Section 01005 and also as specified in other sections

3.04 Maintenance of Documents on Site:

A. Maintain at the job site, one copy of each of following:

1. Latest, revised Drawings, without any mark ups.
2. Employer's Requirement & Specifications.
3. Addenda.
4. Reviewed drawings.
5. Change orders.
6. Other modifications to the Contract.
7. Field test records.
8. Codes and standards.
9. Measurement book maintained and updated on a daily basis.

B. Maintain documents in a clean, dry, legible condition.

C. Make documents available at all times for inspection by the Engineer.

D. Make available on site, one copy of each workmanship standard called for in the Specifications.

E. Maintain record of approved documents and drawings as follows:

10. Two sets of white prints for record purposes.

3.05 Access to Site:

A. The Engineer will authorize access to the construction site. Construct and maintain temporary roads required for the work in a proper and safe condition.

B. Maintain proper and safe access to the existing facility at all times. Ensure that BMC personnel at any existing facility have full access at all times to all areas required for normal operations.

C. Repair promptly any damage to existing access roads, to the satisfaction of the Engineer.

D. Transportation facilities for the employer representative shall be provided by the contractor.

3.06 Access to Work:

A. The Engineer may at any time and for any purpose enter the work site and premises used by the Contractor. Provide proper and safe facilities for access. Others, such as regulatory and permitting agencies, may also, when authorized by the Engineer, enter the work site and premises used by the Contractor for purposes that may be required by their agencies.

B. Provide proper facilities by means of walkways, ladders or otherwise, to secure convenient safe access to all parts of the work as may be required by the Engineer.

C. Place materials such that free access may be maintained at any time to all parts of the work and facilities.

3.07 Work Areas:

A. Work areas are defined on the Drawings or as designated by the Engineer. Confine operations to the designated areas.

3.08 Protection of Construction and Equipment:

A. Protect new construction from damage. Do not overload any Division of a structure, falsework, formwork or scaffolding. Rebuild to the satisfaction of the Engineer damaged portions of the work.

B. Take precautions to protect structures and equipment until completion.

C. Protect equipment supplied and/or installed, from damage, dust, dirt, etc., to the satisfaction of the Engineer. If required, supply temporary housing for equipment or items supplied.

3.09 Protection of Existing Plant and Personnel:

A. Do not endanger in any way the personnel, equipment, plant and existing structures. Exercise caution to keep the existing facilities free from damage due to the Contractor's work. If the measures employed by the Contractor are not considered sufficient, the Engineer may order additional precautions to be taken at no additional cost to BMC.

3.10 Protection of Existing Utilities:

A. Contact the BMC concern utility department for any information with regard to the location of underground utilities. Exercise the necessary care in construction operations and take other precautions as necessary to safeguard the utilities from damage. In case of any damage the contractor shall bear the cost of repairing the damaged utilities.

B. Conduct utility surveys.

C. Provide support and protection for existing utilities.

3.11 Protection of Survey Markers:

A. Preserve survey markers while the work is in progress. Replace survey markers damaged or removed by construction activities, to the satisfaction of the Engineer.

3.12 Protection of Adjacent Property:

A. Do not cause damage to adjacent property. In case of any damage the contractor shall repair in the manner directed by and to the satisfaction of, the Engineer at no additional cost to BMC.

3.13 Protection against Flotation:

A. Control surface and ground water to prevent damage to pipes or structures due to water uplift pressure during and after construction and until the completed works are accepted. Contractor to submit details of the measures which are proposed to be taken to the satisfaction of the Engineer.

3.14 Working Hours:

A. Observe working hours from 08:00 to 18:00, six days a week except as required for shut down purposes. Request the Engineer's approval before scheduling work outside these hours on weekdays. Except for emergency work, do not perform work on Sunday and holidays unless approved by the Engineer.

3.15 Metric Equipment:

A. Where materials are not available in metric units, equivalent imperial units will be acceptable.

B. Where metric and imperial types of equipment are to be installed under the same Contract, be satisfied that mating of metric and non-metric equipment is possible. Provide shop drawings of proposed transition couplings etc to the Engineer before assembly. Provide transition couplings, adapters etc as required for mating of metric and non-metric equipment.

3.16 Photographs and Video:

A. The contractor shall maintain digital photographs in a folder on a daily basis showing work progress

B. Provide, to the Engineer digital photographs showing progress of the work on a monthly basis.

C. The Engineer reserves the right to take photographs and videos of the work at any time.

3.17 BMC's Interest in Equipment and Materials:

A. Ensure that construction plant, temporary facilities and materials, when brought to the site, are exclusively intended for the construction and completion of the work. Do not remove the same or any Division thereof, except from one Division of the site to another, without the consent of the Engineer.

B. Observance of the above item does not necessarily imply approval by the Engineer of the plant, work or materials as the Engineer may reject such items at any time.

3.18 Deleted

3.19 Interpretation of Drawings and Specifications:

A. The Drawings, Specifications and Datasheets are complementary to each other and what is required by any one document is as required by all documents

B. Where the quality of workmanship or materials is not specifically stated, provide the best quality available.

C. The location of un-dimensioned fixtures, outlets, conduits, piping etc, as shown on the drawings are approximate. Make actual locations to suit job conditions.

D. Except where specific dimensions are shown on the Drawings, locate equipment, fixtures, piping, conduits, etc to create the minimum interference with pedestrian access, machinery, traffic and headroom.

E. Although the Drawings have been divided into various categories, they shall be read as a complete package. Details applicable to one category may appear on Drawings pertaining to another category or categories.

F. Although the Specifications or requirements have been divided into Divisions, read it as a complete package.

3.20 Geotechnical Investigations:

A. A geotechnical investigation of the project site shall be carried out .

B. Perform test excavations and/or borehole drilling as required. Protect existing facilities and underground utilities as specified.

3.21 Deleted

3.22 Explosives:

A. Do not use explosives on this project without permission of the Engineer and Explosives certifying Government authorities.

B. Do not use powder-activated tools on any Division of the work unless written approval for their specific use is obtained from the Engineer. Ensure that workers using powder-activated tools are properly trained in their use and all safety rules are adhered to.

3.23 Protection against Termites and Corrosion:

A. Protect all structures, piping, sewers and equipment that may be exposed or buried in the ground during the construction period until the project is completed and accepted. Include such protective measures as anti-termite and anti-corrosion treatments in the Contract price and correct any damage sustained, to the satisfaction of the Engineer.

B. In keeping with the above requirements, submit to the Engineer in writing, before construction begins an outline of specific protection measures to be implemented on this project. The contractor shall be responsible for the proper implementation of such protection measures and damages arising from corrosiveness and termite effects regardless of the review by the Engineer of the protection measures.

3.24 Patent and License Fees:

A. The contractor shall be responsible for design and execution and payment of all applicable patent, copyright or license fees and royalties relating to equipment or processes incorporated into the works.

B. The contractor shall protect BMC from damages and costs that may arise from patent infringements.

3.25 Deleted

3.26 Assistance:

A. The contractor shall provide reasonable assistance to the Engineer’s representative during execution of the work.

END OF SECTION 01000

SECTION 01001- SUMMARY OF WORK

PART 1 -GENERAL

1.01 Reference:

A. Section 01000, applies to and governs the work of this Section.

1.02 Work Covered by the Contract:

Civil Works

A. Supply, Laying, Installation & Commissioning of 2200 mm diameter bypass line for the surge tank for isolation and disconnection of the existing surge tank. Providing an additional 1800mm diameter pipeline from IPS to WwTF to run in parallel and complement the existing 1800mm pipeline including provision of valves and valve chambers, manholes, thrust blocks to upgrade the capacity of the pumping.

B. Providing 2200 mm diameter pipeline of length 10m for connection to the proposed WwTF at Ghatkopar

C. Steelwork, ladders and chequered plates and grating as required for the equipment.

D. Repairs / Modifications / Providing new foundations for the newly installed equipment & Machinery as per specifications including the demolition of existing one.

E. Refurbishment and face lifting of existing structures of Ghatkopar IPS.

F. Construction of new surge tank.

G. Construction of bridge required for pipe crossing across the creek.

H. Reinstatement of existing internal roads of Ghatkopar IPS and connecting road between IPS and WwTF.

PART 2 -PRODUCTS

2.01 Construction Schedule:

A. Prepare and submit a construction schedule, in accordance with Section 01007 and as specified but not limited to followings.

2.02 Ghatkopar Influent pumping station:

1. Identify and relocate existing utilities interfering with construction of the units and internal Roads.
2. Excavation.
3. Refurbishment of Rising Chamber, Screen chamber, Influent Pumping Station, Office Building, Sub Office, Substation Building, Transformer Yard and Parking Shed.
4. Construction of New Surge Tank.

5. Laying of MS Rising main pipeline from IPS to WwTF including thrust blocks and valve chambers.
6. Construction of bridge required for pipe crossing across the creek.
7. Reinstatement of existing internal roads of Ghatkopar IPS and connecting road between IPS and WwTF.
8. Clear the site of all debris, temporary structures and leave the site clean.
9. Submit to the Engineer any further As-built Drawings, and any other documents as required by the Contract.

END OF SECTION 01001.

SECTION 01002 ALTERNATIVES

PART 1 - GENERAL

1.01 Reference:

A. Section 01000 applies to and governs the work of this Section.

PART 2 - EXECUTION

2.01 Equivalents:

A. Where one or more makes or suppliers are specified in the Contract Documents, base the tendered price on using one of these makes or suppliers.

B. Provide equipment from the approved manufacturers/suppliers.

C. No alternative manufacturers/ suppliers are accepted unless “or equal” is specified.

D. No substitutions or alternatives are allowed for equipment unless “or equivalent” is specified.

E. Be responsible for ensuring the proper fit, installation and matching of selected equipment or material.

F. In all cases except Raw Sewage Pumps where a substitution or alternative is proposed other than the approved makes/suppliers, provide written justification to the Engineer indicating the reasons for the substitution (e.g. significant delay in delivery, strikes, unavailability, improved quality or field service, significant contract cost reduction) along with sufficient descriptive and technical information and demonstrate that the alternative proposed is better than the specified product. Failure to comply with this requirement to the Engineer's satisfaction may result in rejection of the request due to insufficient information or time to evaluate it.

G. Engineer’s decision for acceptance/rejection of an alternative will be final.

H. The Contractor will be allowed to make applications and submissions related to substitutions/ alternatives. Sub-contractors applications will not be considered.

I. Bear all liabilities and additional costs that may subsequently arise as a result of the proposed substitution/alternatives having been accepted by the Engineer. Cost reduction for adopting equivalent, will be reduced from the contract value.

J. Optional and/or substituted equipment requiring changes in details or dimensions required to maintain all structural, mechanical, electrical, control, operating, maintenance or design features incorporated in these Specifications and Drawings shall be made at no additional cost. In the event that the equipment proposed varies from that shown, produce detailed calculations and drawings showing proposed revisions and submit same for approval. Coordinate all changes required and pay any additional charges incurred.

END OF SECTION 01002.

SECTION 01003 COORDINATION

PART 1 -GENERAL

1.01 Reference:

A. Section 01000 applies to and governs the work of this Section.

PART 2 - EXECUTION

2.01 Supervision:

A. Maintain on the site at all times a Resident Construction Engineer having full authority to take decisions regarding the execution of the project who is fully qualified to properly direct the progress of this Contract continuously, including the co-ordination and work of sub-contractors. During periods when work on this project is not being carried out, maintain protective fencing or competent security personnel on the site to guard the site and works and the properties and possessions thereon of the Contractor and his sub-contractors as well as those of the BMC.

2.02 Sub contractors:

A. Various Divisions of these volume have not necessarily been segregated into sub-contractors or sub-contracts. Define the scope of work of each sub-contractor and apportion it, with special attention directed toward items or materials that are to be built into concrete, masonry etc.

B. Coordinate architectural, structural, mechanical, electrical and instrumentation work for the equipment being installed.

C. No extra payment will be considered due to difference in interpretation of the Specifications.

D. Should alternative equipment proposed by the Contractor be accepted, coordinate all required changes to other divisions including civil, mechanical, electrical and control works associated with that equipment and bear the extra expense for such changes.

2.03 Co-ordination of Construction with Storm Water Department and Sewage Operation:

A. For the tie-in of the new facilities with existing facilities on the sites, coordinate construction activity under this contract with the SWD/SO Department.

B. Submit a list of services requiring shut-down, anticipated shut-down times and their maximum duration. Tie-in points not limited to following:

1. Incoming sewer line
2. Bypass connection to existing bypass or storm water net work
3. Re-routing of existing sewer lines, rising mains, bypass if required to keep existing pumping station in operation

C. Provide a detailed schedule indicating each phase of the shut-down and start-up of each portion of the works.

D. Provide written procedures for each shut-down and start-up activity.

E. Submit prior written notice as required by the concerned department of BMC and the Engineer where a shut-down is necessary to facilitate construction. Have the proposed timing of such construction reviewed by the BMC prior to initiation of the work related to the shut-down.

F. Obtain the written permission of the Engineer in advance of each shut-down.

2.04 Co-ordination of Construction with Utilities Departments:

A. For the existing utilities which may interfere in the pumping station site and in the way of laying piping, coordinate construction activity under this Contract with the respective utility providers.

1. Water department
2. Telephone department
3. Gas department
4. Fire department
5. Electricity
6. Other utilities providers.

B. Submit a list of utilities requiring shut-down, anticipated shut-down times and their maximum duration.

C. Provide a detailed schedule indicating each phase of the shut-down and start-up of each portion of the existing works.

D. Provide written procedures for each shut-down and start-up activity.

E. Submit prior written notice as required by the concerned department of BMC and the Chief Engineer where a shut-down is necessary to facilitate construction. Have the proposed timing of such construction reviewed by the BMC prior to initiation of the work related to the shutdown.

F. Obtain the written permission of the affected utility providers and the Engineer in advance of each shut-down.

2.05 Co-ordination with Power Supply Company:

A. For obtaining the power for construction, testing, commissioning and operating the pumping stations, coordinate these activities with the Power Supply Company.

B. Have the proposed timing of such activities reviewed by the concern and obtain any necessary written permission from these concerns prior to initiation of the work. Submit copy of the correspondence to Engineer.

2.06 Cutting, Fitting and Patching:

A. Complete the necessary cutting, fitting and patching to ensure the various parts of the work fit properly to complete the work. Complete cutting, fitting and patching as may be required to connect the work with that of any other contractor.

B. Do not endanger any existing work by cutting, digging or any other construction operation.

C. Do not cut load-bearing members without the written permission of the Engineer.

D. Be responsible for costs due to wrongly scheduled work and be responsible for minimum down time.

E. Prior to cutting into existing concrete, in order to avoid damage to any encased piping, conduits etc in the vicinity, ensure that:

1. The locations and the extent of cutting required are coordinated with sub-contractors involved and are accurately and carefully marked out.

2. The walls or slabs are X-rayed prior to drilling openings to determine the location of existing services concealed in and/or behind the structure to be drilled.

3. Permission is received and shop drawings applicable to the affected area have been approved.

2.07 Location of Fixtures:

A. The location of undimensioned fixtures, apparatus, outlets etc shown or specified are approximate. Finalize the actual locations as directed and required to suit conditions at the time of installation and as is reasonable.

B. Before installation, inform the Engineer of the impending installation and consult with him for location details.

END OF SECTION 01003.

SECTION 01004 FIELD ENGINEERING

PART 1 - GENERAL

1.01 Reference:

A. Section 01000 applies to and governs the work of this Section.

PART 2 - EXECUTION

2.01 Construction Layout:

A. Be responsible for design and laying out the work, based on the benchmark and reference lines shown on the Drawings or established by the Engineer.

B. Erect a permanent bench mark at each site with x, y, z co-ordinates.

C. Be responsible for the accuracy of levels and layout during the construction period and of the finished work.

2.02 Vertical and Horizontal Control:

A. Erect stakes, sight lines and batter boards so that they will not be disturbed during excavation. Protect and preserve reference points during construction.

B. The Engineer may check the layout and point out discrepancies. There is no obligation upon the Engineer to check the Contractor's work. Be responsible for lines and grades regardless of the Engineer’s action or lack of action in checking same.

C. Report immediately to the Engineer any discrepancies seen in the drawings.

2.03 Field Measurements and Tests:

A. Measure field dimensions required for the proper execution of the work. Carry out field measurements of critical items such as piping specials required to fit into confined spaces and between equipment before fabrication and show on the shop drawings.

B. Field verify the locations and elevations of existing structures and existing services that are to be connected to or that affect lines to be installed or structures to be connected.

2.04 Pre-construction Inspection:

A. Prior to construction, undertake an inspection of buildings involved in or in the vicinity of the proposed construction. Have the pre-construction inspection documented in writing, in photographs and videos as appropriate, noting surface finish conditions of structures and possible cracks. Be responsible for repairing damage to existing structures caused by construction.

B. Provide to the Engineer two copies of the report documenting the pre-construction inspection including photographs.

END OF SECTION 01004.

SECTION 01005 REGULATORY REQUIREMENTS

PART 1 - GENERAL

1.01 Reference:

A. Section 01000 applies to and governs the work of this Section.

1.02 Codes and Standards:

A. Where applicable, ensure that materials, equipment etc confirm to the Standards listed in the Divisions and their Sections.

B. Perform work in accordance with the requirements contained in the latest editions of the following statutes and codes:

1. Safety Manual - Central Water and Power Commission, Ministry of Irrigation and Power, Government of India
2. National Building Code of India -2005
3. All regulations, codes and ordinances of the Govt of India, Govt. of Maharashtra and Brihanmumbai Municipal Corporation regarding safety.
4. Indian Electricity Rules – 1956
5. Fire Safety Act – 1986
6. The Indian Contract Act, 1872.
7. The Workmen’s Compensation Act, 1923.
8. The Minimum Wages Act, 1948.
9. The Contract Labour (Regulation & Abolition) Act, 1970.
10. The Indian Arbitration Act (1940)
11. Indian Factories Act- 1948
12. Maharashtra Factory Rules- 1963

C. Contractor for this project will assume the responsibility set out in the above mentioned Acts and its regulations.

D. The Contractor shall indemnify the BMC, consultant and other supervising authority for any accident during contract period.

1.03 Statutory Regulations:

A. The Design and construction of the works and the operations connected therewith are subject to the approval, inspection, by-laws, and regulations of municipal, state and central government authorities and organizations concerned with roads, streets, railways, telephones, electrical supplies, gas supplies and other public services having jurisdiction in respect to any matter embraced in this Contract.

PART 2 - EXECUTION

2.01 Approvals and Permits:

A. Apply for, obtain and pay for permits required for the project, including but not limited to:

1. Tree cutting and plantation permit
2. Plumbing permit

3. Electrical Safety Authority
4. Power Supply Authority
5. Road Authority
6. Police Authority
7. Fire Safety permit
8. Building Construction permit
9. Disposal of excess excavated material and debris from construction and demolition
10. Other permits and regulation requirements as may be applicable.

B. Submit copies of all permits to the Engineer.

C. BMC will assist in obtaining permission and approvals by providing recommendation letters or letters on BMC letterhead to be written to various authorities as may be necessary.

D. Arrange for regular inspections as required by authorities having jurisdiction and the required final inspections.

E. Provide to the Engineer, on a monthly basis, a report of inspections.

2.02 Permit to Take Water:

A. A Permit to Take Water is required if pumping ground water is likely to be involved. Comply with the BMC's requirements and obtain Permit to Take Water before commencing dewatering operations.

B. Contractor shall be responsible for any delays or costs that may arise from obtaining the permit from the respective authorities.

END OF SECTION 01005

SECTION 01006 PROJECT MEETING

PART 1 - GENERAL

1.01 Reference:

A. Section 01000 applies to and governs the work of this Section.

PART 2 - EXECUTION

2.01 Kick-off Meeting:

A. A kick-off meeting will be arranged by the Engineer within 15 days of issue of letter of acceptance. The purpose of this meeting will be to initiate the work under this Contract, to acquaint the Contractor's and the Engineer's designated personnel with each other and to discuss the work procedures and preliminary scheduling. Ensure that a senior Contractor's representatives in charge of each designated site are in attendance, along with the following:

1. Bar chart for design document submission, work & detailed mobilization chart.
2. Sequencing – procedure of work to be executed
3. Safety Plan.
4. Quality Assurance Plan.
5. Required guarantees.
6. Site organization with names and qualification.
7. Biodata of key persons
8. Subcontractors list.

2.02 Progress Meetings:

A. Attend progress meetings as required by the Engineer or Engineer’s designated person. Such meetings to be held monthly or more frequently should the Engineer or engineer’s designated person deem it necessary. Ensure the attendance of responsible persons who have the required authority to execute decisions reached at the meeting. Subcontractors, vendors and others must attend as and when requested by the Engineer.

B. Meeting notes will be prepared and circulated by the Engineer or Engineer’s designated person.

END OF SECTION 01006

SECTION 01007 SUBMITTALS

PART 1 - GENERAL

1.01 Reference:

A. Section 01000 applies to and governs the work of this Section.

1.02 Work Included:

A. Submittals covered by these requirements include, but are not necessarily limited to:

1. Design calculations, documents and drawings
2. Construction methodology
3. Construction schedule
4. Certificate of Insurance
5. Design document submittal schedule and regular updates of its approval
6. drawings/ catalogues and documents as specified in each division
7. Other specific documents as requested in other sections.
8. Instructions for storage / warehousing of materials and equipment.
9. Instruction for installation and commissioning of equipment.
10. List of special tools for installation & maintenance.
11. Quality Control Records as Specified in Section 01008.
12. Commissioning procedures and documents as specified in Section 01014.
13. Operation and Maintenance Manuals as specified in Section 01015.
14. "AS BUILT" drawings/documents as specified in Section 01016.
15. Safety Plan.
16. Environmental and Emission data list
17. List of Permits with copies of each permit
18. Shipping documents with release notes
19. Conformity /non-conformity reports
20. Other documents as requested by Engineer
21. Shoring, strutting, shuttering, scaffolding designs and calculations.
22. Bar bending schedules
23. Concrete insert schedules including locations.
24. Plan for locating temporary facilities including site offices with toilet facilities and 24 hour water supply, cement and other material godown, toilet block for workers with sewage disposal line.
25. Measures proposed to be taken to prevent damage to the structure due to floatation during construction and till completion of work.

1.03 Categories of Submittals:

A. Prepare a document submittal schedule indicating dates and categories within three weeks from Award of Contract or Letter of Intent for the Engineer's approval.

B. Submittals fall into three categories: submittals for review and comment, submittals for information and submittals for record.

C. Intent is not to provide complete list but a guide to decide the categories of document.

D. Submittals that are primarily for information only are not subject to submittal review procedures and will be provided as part of the work under this Contract.

E. The Engineer will retain these documents for information, however upon review he may provide comments if any. The following documents can be classified in the "For Information" category:

1. Instructions for storage / warehousing,
2. List of special tools for installation & maintenance,
3. Instructions for installation/ commissioning,
4. Commissioning/Mandatory Spare parts list,
5. Certificates of insurance,
6. Safety plan,
7. Test procedures, test results, certificates and manufacturers' / suppliers' instructions,
8. Commissioning procedures,
9. Operations and maintenance manuals and
10. Similar documents

F. Submittals for review and comment are specified in the Contract Documents and include, but are not limited to, design and detailed engineering documents & drawings, shop drawings, construction schedules, samples, coordination drawings, and construction coordination and sequencing plans. The Engineer will review the submittals and may provide comments. The Engineer's review and comments, or lack of comments, will not relieve the Contractor of his responsibilities under the Contract. Structure modeling, analysis and design calculations (Microsoft Excel, Staad Pro etc.) files shall be submitted in editable format through emails or in CD.

G. Submittals for record are specified in the Contract Documents and include, but are not limited to, "AS-BUILT" drawings, vendor/suppliers data/records/Instructions etc in separate volumes, operation and maintenance manuals, test records, reports, certificates etc.

1.04 Contractor's Responsibilities:

A. Provide submittals to the Engineer as specified.

B. Be responsible for the accuracy and completeness of the information contained in each submittal and ensure that the material, equipment or method of work is as described in the submittal. Verify that features of products confirm to the specified requirements. Edit submittal documents to indicate only those items, models or series of equipment that are being submitted for review. Cross out or otherwise obliterate extraneous information. Coordinate submittals among the sub-contractors and suppliers and ensure there is no conflict. Notify the MCGM in each case where a submittal may affect the work of other contractors of the MCGM. Carry out any relocation/ modification of work due to lack of coordination at no additional cost to the MCGM.

C. Verify that the materials and equipment to be furnished and method of work comply with the provisions and the intent of the Contract.

D. Verify and guarantee that features and characteristics of materials, equipment and other items to be incorporated into the work, and for which no submittals are required, conform to the Contract requirements.

E. Submissions to include design calculation, design documents, drawings, erection details, co-ordination issues, phasing, assessment of problem issues.

F. Coordinate submittals with the work so that work will not be delayed. Coordinate and schedule different categories of submittals, so that one will not be delayed for lack of coordination with another. No extension of time will be allowed because of failure to properly schedule submittals.

G. Do not proceed with work related to a submittal until the submittal approval and review process is complete. This requires that submittals for review and comment are returned to the Contractor stamped "REVIEWED" or " REVIEWED AS NOTED".

H. Stamp, date and sign /initial each submittal to certify that the Contractor has verified the submittal, field conditions, and compliance with the Contract Documents.

I. The Engineer's review of submissions does not relieve the Contractor of responsibility for correctness, adequacy, engineering and compliance with the Contract.

J. Arrange a meeting with the supplier and the Engineer with regard to a submittal whenever requested. These dealings are limited to contract interpretations to clarify and expedite the work.

1.05 Effect of Review of Contractor's Submittals:

A. Submittals provide information concerning features and characteristics of materials, equipment and methods of operation selected based on the Contractor's judgment of their conformance to the specified requirements. Review of submittals does not extend to means, methods, techniques, sequences or procedures of construction, or to verifying quantities, dimensions, weights or gauges, or fabrication processes, except where specifically indicated or required by the project requirements or to safety precautions or programmes incident thereto. Review of a separate item, as such, will not indicate approval of the assembly in which the item functions.

B. The review of methods of work, or information regarding materials or equipment the Contractor proposes to provide, shall not relieve the Contractor of his responsibility for errors therein and shall not be regarded as an assumption of risks or liability by the MCGM, or by any representative officer, employee or agent thereof. The Contractor shall have no claim under the contract on account of the failure, or partial failure, of the material, or equipment so reviewed.

C. The review of detailed engineering documents and drawings or shop drawings shall not relieve the Contractor of his responsibility for errors therein, and shall not be regarded as assumption of risks or liability by the MCGM, or by any representative officer, employee or agent thereof. The Contractor shall have no claim under the contract on account of the failure, or partial failure, of the material, or equipment in the drawings so reviewed. A mark of "REVIEWED" or "REVIEWED AS NOTED" shall mean that the MCGM has no objection to the Contractor, upon his own responsibility, providing the materials or equipment proposed.

D. The Engineer will review detailed engineering documents and drawings for general arrangement, design calculations and design basis report. Revised drawings shall be submitted by clouding at the location with latest revision number and also the history of revisions shall be provided in a table format above the title block.

E. The Engineer will review drawings for general arrangement only. The Contractor shall be responsible for checking dimensions, quantities, proper fitting and construction of the work, and for furnishing materials or doing work required by the Contract Documents, which may not be indicated on drawings when reviewed.

1.06 Detailed Drawing and Document Review Procedure:

A. Unless otherwise specified, within fifteen (15) business days after the Engineer receives a detailed drawing or a design document submittal for review and comment, the Engineer shall review the submittal and return one (1) copy of the marked-up drawing or document bearing the Review Status stamp. The returned submittal shall indicate one of the following actions:

1. If the review indicates that the design document or drawing or calculation complies with the Contract Documents, the submittal will be marked "APPROVED AS SUBMITTED". In this event, the Contractor may proceed for fabrication or construction.

2. If the review indicates limited corrections are required, the submittal will be marked “APPROVED SUBJECT TO COMMENTS NOTED”. The Contractor may proceed for fabrication or construction covered by the submittal in accordance with the noted corrections. Provide six copies of a corrected design document / drawing / calculation with corrections.

3. If the review reveals that the submittal is insufficient or contains incorrect data, the submittal will be marked "RESUBMIT AS NOTED". Make the changes to the design document or drawing or calculation that the Engineer may require. Identify changes on resubmissions and indicate the revision dates. Accept all risks associated with undertaking work covered by this submittal until it has been revised, resubmitted and returned marked either "APPROVED AS SUBMITTED".

4. If the review indicates that design document / drawing / calculation do not comply with the Contract Documents, the submittal will be marked "RETURNED WITHOUT REVIEW”. Accept all risks associated with undertaking the work covered by such submittals until a new submittal is made and returned marked either “APPROVED AS SUBMITTED" or "APPROVED SUBJECT TO COMMENTS NOTED".

B. Claims for additional compensation in time or funds due to delays in re-submissions and review of design document / drawing / calculation will not be allowed.

1.07 Shop Drawing Review Procedure:

A. Unless otherwise specified, within fifteen (15) business days after the Engineer receives a shop drawing submittal for review and comment, the Engineer shall review the submittal and return one (1) copy of the marked-up shop drawing bearing the Shop Drawing Review stamp. The returned submittal shall indicate one of the following actions:

1. If the review indicates that the material, equipment or work method complies with the Contract Documents, the submittal will be marked “APPROVED AS SUBMITTED". In this event, the Contractor may begin to incorporate the material or equipment covered by the submittal into the work.

2. If the review indicates limited corrections are required, the submittal will be marked "APPROVED SUBJECT TO COMMENTS NOTED”. The Contractor may begin incorporating the material or equipment covered by the submittal in accordance with the noted corrections. Provide six copies of a corrected shop drawing for incorporation in the operations and maintenance data.

3. If the review reveals that the submittal is insufficient or contains incorrect data, the submittal will be marked "RESUBMIT AS NOTED". Make the changes to the shop drawings that the Engineer may require. Identify changes on resubmissions and indicate the revision dates. Accept all risks associated with undertaking work covered by this submittal until it has been revised, resubmitted and returned marked either "APPROVED AS SUBMITTED" or "APPROVED SUBJECT TO COMMENTS NOTED".

4. If the review indicates that the material or equipment does not comply with the Contract Documents, the submittal will be marked "RETURNED WITHOUT REVIEW". Accept all risks associated with undertaking the work covered by such submittals until a new submittal is made and returned marked either "APPROVED AS SUBMITTED" or" APPROVED SUBJECT TO COMMENTS NOTED ".

B. Claims for additional compensation in time or funds due to delays in re-submissions and review of shop drawings will not be allowed.

PART 2 - PRODUCTS

2.01 Construction Schedule:

A. Submit a construction schedule showing the contract starting date and the commencement and the completion of each substantial or key portion of the work. Provide the schedule to the Engineer for review within fourteen (14) days after the award of contract. Include in the schedule the work of any sub-contractor, submission dates for shop drawings and the project completion date.

B. Indicate in the Construction Schedule the Critical Path of the work including, but not limited to, the following:

1. Identification and listing in chronological order of all construction, demolition and removal activities required to complete the Work, such as mobilization and other activities; all subcontractor work; major equipment design, fabrication, factory testing, and delivery dates; equipment system testing and start-up activities; project closeout, cleanup and site restoration; and specified work sequences, constraints, and milestones, including Substantial Completion dates.
2. Identify timeframe, duration, early start and completion for each activity and sub-activity, and any critical activities.
3. Sub-schedules, such as Staging Plans and Sequencing Plans as required, to further define portions of the Work.
4. Shop drawing submission dates related to equipment or activity on the schedule.

2.02 Shop Drawings:

A. Submit shop drawings, bar bending schedules, piping arrangements, support/anchors, fabrication and erection drawings, design calculations etc where applicable, for all work in this Contract.

B. Submit shop drawings for all temporary works that control the dimensions of any part of the structures to be constructed under this Contract, or which impose loads on parts of the completed permanent works.

C. Ensure that shop drawings of mechanical and electrical equipment show details of construction, accurate dimensions, capacities and performance characteristics, including wiring, conduits and piping isometrics, and instrumentation etc.

D. Ensure that shop drawings clearly show exposed fastenings and, where applicable, installation details, relationship to the building structure and/or finishes.

E. Manufacturer's standard schematic drawings, catalogue sheets, diagrams, schedules, performance charts, illustrations and other standard descriptive data may be accepted in-lieu of shop drawings, if they:

1. Supplement standard information to provide additional information applicable to the project.
2. Show dimensions and clearances required.
3. Show performance characteristics and capacities.
4. Show wiring diagrams and controls.

Any non-applicable information to be deleted.

F. Submit shop drawings in SI metric units. Shop drawings in Imperial units only will be returned by the Engineer without review.

2.03 Coordination Drawings:

A. Prepare Coordination Drawings for areas of potential conflict, where interference may be caused by uncoordinated use of available space by the various subcontractors, clearly show on the same drawing the proposed works of all disciplines, such as process piping, plumbing and drains, air ducts, electrical cable trays and conduits, including valve orientation and access.

B. Show piping and other services that are to be cast into concrete.

C. Submit Coordination Drawings for review as specified prior to commencement of the work.

D. Update and resubmit the Coordination Drawings when changes and relocations are to be made.

E. Carry out any relocation of work due to interference.

2.04 Construction Coordination and Sequencing:

A. Submit a detailed Staging Plan outlining the steps to be taken to construct the works. Review the proposed Staging Plan and discuss timing and constraints with the MCGM's operations staff. Both the MCGM and the Engineer reserve the right to request revisions to either the stages and or the timing. Do not proceed with the work until the Staging Plan has been reviewed and accepted by the MCGM.

B. Prepare and submit, to the Engineer, Sequencing Plans where interferences exist and where a specific work sequence is required to avoid or minimize operational interruptions of the existing facilities. Tie the Sequencing Plans to the project schedule.

2.05 Other Submittals:

A. Submit promptly, all other items required to be submitted in accordance with various Sections of the Specifications including but not limited to:

1. Test reports of concrete and materials, proposed to be used in concrete mix design, by concrete supplier.
2. Manufacturers cement test report for each batch from each supplier.

3. Batch report with each truck of ready mixed concrete.
4. Lab test report for reinforcement weight and grade for each lot supplied.
5. Manufacturer test certificate for all reinforcement diameter bars for each lot supplied.
6. Electrical Coordination Study in accordance with Division 16.
7. Warrantees and Guarantees
8. Summary list of loose items and spare parts in a tabular form with columns indicating Specification Section, Item Number, Description, Number of Units, and Expected Date of Delivery.

PART 3 - EXECUTION

3.01 Transmittal Procedure for Submittals:

A. When the Contract Documents require a submittal, submit the specified information as follows:

1. Six copies of all submitted information for review and comment, unless specified otherwise.
2. One Electronic Copy of the same submission document in PDF.

B. Have each submittal accompanied by Form 01300-A Submittal Transmittal Form included in Section 01017. Apply a unique number, sequentially assigned, on the transmittal form. Original submittal numbers to have the following format: "XXX"; where "XXX" is the sequential number assigned by the Contractor. Re-submittals to have the following format: "XXX-Y"; where "XXX" is the originally assigned submittal number and "Y" is a sequential letter assigned for re-submittals, i.e., A, B, or C being the 1st, 2nd, and 3rd re-submittals, respectively. Submittal 25B, for example, is the second re-submittal of submittal 25.

C. On the transmittal form, clearly identify Contract, Contract No, Contractor, Pertinent Drawing No, Specification Sheet No, and Article No, as applicable, for the submittal.

D. Use a separate transmittal form for each specific item, class of material, equipment, and items specified in separate, discrete sections, for which the submittal is required. Submittal documents common to more than one piece of equipment to be identified with all the appropriate equipment numbers. Make submittals for various items with a single form when the items taken together constitute a manufacturer's package or are so functionally related that expediency indicates checking or review of the group or package as a whole.

E. Submittals for operation and maintenance manuals, information and data are to be accompanied by Form 01700-A, Operation and Maintenance Transmittal Form included in Section 01017. Refer to Section 01016 for additional requirements.

3.02 Submittal Completeness:

A. Submittals that do not have all the information required to be submitted, including acknowledgement of deviations, are not acceptable and will be returned without review.

B. Bear the cost of any delay or cost implications arising from the improper submittals.

3.03 Drawing Transmittal Procedure:

A. Check drawings before submission to the Engineer for review to coordinate the activities on the project and intercept errors and omissions.

B. Failure to complete and submit with the drawings by Form 01300-A, in particular in the Contractor's certification section, shall be sufficient for rejection of the entire submittal with no further consideration.

C. Include in every drawing submission, a copy of the relevant specification section, with addendum updates included, and all referenced and applicable sections, with addendum updates included. Check-mark each paragraph to indicate compliance with the specification or mark otherwise to indicate requested deviations from specified requirements. Check marks (√) denote full compliance with a paragraph in its entirety. If deviations from the specifications are indicated, underline each point of deviation and denote by a number in the margin to the right of the identified paragraph. The remaining portions of the paragraph not underlined will signify compliance with the specified requirements. Provide in the submittal a detailed, written justification for each deviation.

D. Failure to include a copy of the marked-up specification sections, along with justifications for any requested deviations to specified requirements, with the submittal shall be sufficient cause for rejection of the entire submittal with no further consideration.

3.04 Construction Schedule:

A. Update the progress schedule when requested by the Engineer. As a minimum, distribute, four days prior to site meetings, monthly updates to the construction schedule.

B. If an activity is not completed by its latest scheduled completion date and this failure may extend the Contract Time (or may affect the project critical path), within seven days of such failure, submit a written statement as to how the non-performance will be corrected and the original schedule will be maintained.

C. Regardless of the schedule or schedules submitted by the Contractor, the Engineer reserves the right to direct the Contractor by employing whatever means necessary, to expedite the work.

D. Be responsible for duties and responsibilities under the Contract, regardless of submissions to, and review by the Engineer of schedules or construction programs or any particulars thereof.

END OF SECTION 01007

SECTION 01008 QUALITY CONTROL

PART 1 -GENERAL

1.01 Reference:

A. Section 01000 applies to and governs the work of this Section.

1.02 Work included:

A. Be responsible for maintaining quality and to keep necessary QA/QC records. Ensure that sub contractors and suppliers maintain the same quality requirements.

B. Contractor to select vendors, who are ISO 9000 certified or who maintain equivalent ISO 9000 quality procedures/records and will submit suppliers' Quality Assurance Plan and Quality Control procedure for the Engineer's approval.

C. If required, the Engineer may select a third party for quality control.

D. Ensure that materials, fixtures, fittings, appliances and equipment and appurtenances provided under this Contract are new, suitable for the application and free from any defects; to the satisfaction of the Engineer.

E. Inspection and testing as specified in this section and other sections of the Contract Documents.

F. Inspection and testing required by law, ordinances, rules, regulations or orders of public authorities.

1.03 Submittals:

A. Submit documents, not limited to the following, to maintain quality in accordance with Section 01007.

1. Method statements for various activities including sequence, procedure, inspection & working, checking & Quality Assurance method etc.
2. Inspection and test plans and procedures,
3. Quality records – ISO 9000 certificates,
4. QC dossier / code data books/ record book,
5. Welding procedure specifications,
6. Welding procedure qualification records,
7. Welder qualification records,
8. Weld map,
9. NDE /Radiography procedures,
10. NDE /Radiography reports,
11. NDE /Radiography operator qualifications,
12. Test reports (all types),
13. Pressure test certificates,
14. Material certificates,
15. Inspection reports including sub-vendors,
16. Concrete testing,
17. Compaction tests,
18. Painting / galvanising inspection reports,
19. Construction / installation quality control plans,
20. Equipment calibration certificates,

21. Certificates of conformity,
22. Non-conformity reports (internal & sub-vendor),
23. Shipping releases and
24. Others as required.

B. Neatly assemble and submit quality records in accordance with Section 01016.

PART 2 - PRODUCTS

There is no product in this section.

PART 3 - EXECUTION

3.01 Inspection and Testing:

A. For day- to-day activities requiring checking and approval by the Engineer or Engineer's designated person for next stage, the Contractor must notify the Engineer by providing a weekly programme of the following week only in case of emergencies a minimum 24 hour notice shall be provided.

B. Adhere to the provisions of the Contract, especially with regard to the quality of the workmanship and materials.

C. Perform work under the Contract to the satisfaction of the Engineer. Immediately execute orders given by the Engineer relating to quality of material or workmanship.

D. The Engineer may stop the work entirely if there is not a sufficient quantity of suitable and approved material on the site to carry on the work properly, or for any good and sufficient reason.

E. The Engineer may have any worker suspended for incompetence, substance abuse, negligence or the disregard of orders. Ensure that any worker so suspended is removed from the site promptly.

F. The Engineer or Engineer's designated person may inspect and test materials/ equipment and the process of preparation/ manufacturing of materials/ equipment at any time. The Contractor will submit inspection call to Engineer for witnessing the inspection and testing of materials/ equipment. If these do not meet quality standards, he may reject material or equipment.

G. In case of materials or equipment which, as specifically stated in the Contract, are required to be tested or inspected in the presence of the Engineer or Engineer's designated person, the Contractor must notify the Engineer in writing at least fifteen days in advance, the time and place of proposed preparation / manufacture of such material or equipment so that the Engineer or Engineer's designated person may be present.

H. Do not deliver to the site, until authorized to do so in writing by the Engineer, any material or equipment, which is required by the Contract or by the Engineer, to be inspected and/or tested by the Engineer at the place of preparation or manufacture.

I. Do not use material or equipment required by the Contract or by the Engineer to be inspected or tested until the required inspection or testing has been carried out to the satisfaction of the Engineer or Engineer's designated person.

J. Provide and ensure that suppliers/sub-contractors and those carrying out the process of preparation or manufacture provide required documents/facilities, access and co-operation to the Engineer or Engineer's designated person during inspection and testing.

K. Be responsible for the obligations under the Contract regardless of the approval by the Engineer or waiver of an inspection. Do not interpret action or lack of action of the Engineer as being an acceptance of defective or improper work or material. Remove and replace properly or otherwise rectify such work or material to the satisfaction of the Engineer.

L. If it is required by the Contract, local laws / by-laws, or by the Engineer, to have any part of the works to be inspected by others, give the Engineer and the other concerned parties, reasonable notice of the time and place proposed for the inspection.

M. Where required by the Engineer, supply samples and certified copies of test reports pertaining to materials to be used in the construction of the works, indicating that materials comply with the Specifications. Ensure that such tests are carried out by testing companies/agencies approved by the Engineer.

N. Any and all materials or manufactured products may be tested. As directed, provide test samples for testing of materials or manufactured products being used or proposed for use in the work. Provide adequate time in the project schedule for testing as specified.

O. Immediately remove from the site materials whose test specimens fail to meet specified requirements and those materials that are rejected upon inspection.

P. Where test specimens fail to meet specified requirements or where re-testing is required to verify the quality of work previously tested, provide additional test specimens and pay for the additional testing until satisfactory test results are obtained.

Q. Quality control inspections, as required, other than those noted above will be carried out by inspectors or inspection services under the direction of the Engineer. Provide clear access to work areas to be inspected and assist as required by providing safety equipment, ladders, materials etc, for these inspections.

R. Expenditure on any and all tests required to be carried out shall be borne by the Contractor.

3.02 Receipt and Acceptance of Materials:

A. During the process of unloading any material etc, inspect it for loss or damage in transit in the presence of the Engineer. Notify the agent of the carrier of any loss or damage to the shipment and to the insurance company.

B. The Engineer may reject materials supplied by the Contractor if found faulty or defective. Replace such faulty or defective materials. Be responsible for removing faulty or detective materials and replacing same with good materials regardless of when the defects are discovered.

3.03 Mandatory Tests for Building Materials:

A. Carry out specified optional tests or other tests, as requested by the Engineer, for specialized works or important structures.

B. In case of non-IS materials, it shall be the responsibility of the Contractor to establish the conformity of material with relevant IS and this specification by carrying out necessary tests.

The mandatory tests shall include, but are not limited to, the following:

No.	Activity		Name of Test	Frequency of Test	Field/Lab. Test	Remarks
1	Water	a	Suitable for Conc.	Start & Change of Source	Laboratory	IS 3025
2	Soil Compaction	a	Initial Soil Test	Start & Change of Source	Laboratory	
		b	OMC Proctor Test	2 tests for 50 sqm	Field/Lab	IS 12175
		c	Backfill Soil	Start & Change of Source	Laboratory	IS 2720
3	Concrete	a	Pour Card	before each pour	Field	
		b	Slump Test	One For Each Transit Mixer or 5 m^3 of Site Mix	Field	IS1199
		c	Crushing Strength	See Note	Laboratory/Field	IS 516
		d	Concrete Mix Design	Start & Change of Source	Laboratory	For All Grade
4	Ready Mix Conc.	a	Pour Card	Before Each Pour	Field	
		b	Supplier Mix Design	Before Start Of Work	Laboratory	
		c	(Balance As Above)			
5	Sand	a	Silt Content	Each Truck	Field	IS 383
		b	Bulkage	On Day of Conc.	Field	
		c	Moisture Content	On Day of Conc.	Field	
		d	Sieve Analysis	Each Truck	Laboratory/Field	
		e	Specific Gravity	Start &Change of Source	Laboratory	
		f	Particle Size & Distri.	For Every 40 m^3	Field	IS 383
		g	Foreign /Clay/Organic Material	Each Truck	Field	IS 383
6	Aggregate	a	Size/Type/Colour	For Every 40 m^3	Field	IS 2386
		b	Particle Size	Every 40 m^3	Field/Lab.	
		c	Impact Value	Start & Change of Source	Laboratory	
		d	Flakiness	Each Truck	Field	
		e	Specific Gravity	Start & Change of Source	Laboratory	
		f	Bulk Density	Start & Change of Source	Laboratory	
		g	Sieve Analysis	Start & Change of Source	Field	
		h	Soundness	Start & Change of Source	Laboratory	
		i	Alkali Test	Start & Change of Source	Laboratory	
7	Reinforcement	a	Manufacturer Cert.	Each Lot	Field	
	Steel	b	Unit Weight	Each Lot	Field	
		c	Bend Rebend Test	Each Lot	Factory	IS 11786
		d	0.2% Yield Stress	Each Lot	Laboratory	IS 11786
		e	% Elongation	Each Lot	Laboratory	IS 11786
		f	Chemical Composition	Each Lot	Laboratory	IS 11786
		g	Bend, Rebend Test	Each Lot	Laboratory	
		h	Coating Manuf. Cert.	with each Lot	At Factory	
8	Cement	a	Date & Manuf. Report	Each batch	Field	
		b	Weight of Bag	5% from each Truck	Field	
		c	Make	Every Truck	Field	
		d	Compressive Strength	Each batch	Laboratory	IS 4031
		e	Physical Condition	Every Truck	Field	
		f	Setting Time	Each batch	Laboratory	IS 4031
		g	Soundness	Each batch	Laboratory	IS 4031
		h	Fineness	Each batch	Laboratory	IS 4031
			Age Of Cement Bags	Reject More then 60days	Field	
9	Structural Steel	a	Manufacturer Cert.	Every Truck	Laboratory	
		b	Tensile Stress	Start & Change of Source	Laboratory	

No.	Activity		Name of Test	Frequency of Test	Field/Lab. Test	Remarks
		c	% Elongation	Start & Change of Source	Laboratory	
		d	Yield Stress	Start & Change of Source	Laboratory	
		e	Chemical	Start & Change of Source	Laboratory	
		f	Unit Weight	Start & Change of Source	Laboratory	
		g	Straight/Warping	Every Truck	Field	
		h	Rusting/Scaling	Every Truck	Field	
10	Bricks	a	Broken Edges	Every Truck	Field	
		b	Shape and Size	Every Truck	Field	IS 3495
		c	Soundness	Every Truck	Field	
		d	Drop Test	Every Truck	Field	
		e	Water Absorption	Every 50000	Laboratory	IS 3495
		f	Crushing Strength	Every 50000	Laboratory	IS 3495
11	Aluminium Windows and Doors	a	Size & Weight	Each Section	Field	
		b	Warping	Each Section	Field	
		c	Glass Thickness	Each Lot	Field	
		d	Glass Make	Each Lot	Field	
		e	Scratches	Each Lot	Field	
		f	Anodic coating	Rs.20000/ or More Value	Laboratory	IIS 5523
12	Tiles	a	Make	Each Lot	Field	
		b	Size	Each Lot	Field	
		c	Corners	Each Lot	Field	
		d	Warping	Each Lot	Field	
		e	Colour/Shade/Finish	Each Lot	Field	
		f	As Per Sample	Each Lot	Field	
		g	Tests As Per Is Specs.	Every 30000 Tiles	Laboratory	
		h	Sample Panel	At Start of Work	Field	EACH TYPE
13	Paint	a	Manufacturer Cert.	Each Lot	Field	
		b	Type	Each Lot	Field	
		c	Colour	Each Lot	Field	
		d	Sample Panel	At Start Of Work	Field	EACH TYPE
		e	Manuf. Date	Each Can	Field	
		f	Condition	Each Lot	Field	
		g	As Per Sample	Each Lot	Field	
14	Pipes	a	Manufacturer Cert.	Each Lot	Field	
		b	Pressure Testing	Each Length Of Laying	Field	

C. During the process of unloading any material etc, inspect it for loss or damage in transit in the presence of the Engineer or Engineer's designated person. Notify the agent of the carrier of any loss or damage to the shipment and to the insurance company.

END OF SECTION 01008

SECTION 01009 TEMPORARY FACILITIES AND CONTROLS

PART 1 - GENERAL

1.01 Reference:

A. Section 01000 applies to and governs the work of this Section.

1.02 Work Included:

A. The work under this Section includes, but is not limited to, provision of:

1. Access to the site and the work.
2. Access to the existing facility.
3. Temporary facilities including site and building enclosures, storage areas, shelters, sanitary facilities, Engineer's field office, drinking water requirements.
4. Temporary utilities.
5. Temporary controls, including fire protection, first aid, security, traffic control.

PART 2 - PRODUCTS

2.01 Temporary Site Enclosures:

A. Provide and erect temporary site enclosures to prevent accidents as required and directed by Engineer.

2.02 Storage Areas:

A. Storage areas shall be as approved by the Engineer. Store materials properly to ensure and preserve their quality and fitness for the work. Store materials on wooden platforms or other hard, clean surfaces off the ground or in a watertight storage shed of sufficient size for the storage of materials that might be damaged by storage in the open. Provide the shed with a wood floor raised a minimum of 150 mm clear of the ground.

B. Locate stored materials to facilitate prompt inspection.

2.03 Engineer's Field Office:

A. Provide temporary offices for the Engineer or Engineer's designated person, separate from those of the Contractor.

B. Provide, for the sole use of the Engineer or his representatives, at each Site, a field office of at least 25 m^2.

1. Supply and maintain the offices, satisfactory to the Engineer, for the exclusive use of the Engineer for the duration of the Contract.
2. The office to be set up in approved location within fifteen days of notification to commence work or actual work commencement whichever occurs first.
3. Locate the office within the work area as approved by the Engineer, physically separated from any other structure.
4. Provide a windproof, weather tight structure having a floor area of not less than 25 m^2 and minimum 2.4 m ceiling height.
5. Provide doors with suitable locks. Locate exterior doors on the same side of the office.
6. Provide at least two standard sized windows, on the opposite wall in which the door is located.

7. Provide potable water and washroom facilities for the sole use of the Engineer.
8. Provide janitorial services and all washroom supplies.
9. Equip the office with:
    a) One standard office desk (with drawers) and chair;
    b) One legal-size, 4 drawer file cabinet with lock and key;
    c) Eight additional chairs of the stacking type for use during meetings;
    d) Fire extinguisher and first aid kit;
    e) Shelves, plan racks and a storage cabinet, for storing instruments and clothing;
    f) Window shades and screens.
    g) Air-conditioner.
10. Provide and maintain electrical service connections.
11. Provide photo copying and printing facilities.
12. Provide laptop of following configuration at each site. Laptop to have scanner and internet facilities for exclusive use of the Engineer and its representative:
    a) Operating system installed – 64 bit Windows 10
    b) Processor family - Intel Core i7
    c) 4 GB RAM
    d) Internal drives - 1TB
    e) Display size (diagonal) – not less than 15.0”
    f) Latest graphic media accelerator
    g) 8 GB pen drive -2 Nos
13. Provide one digital camera with the following components and characteristics each site for the exclusive of the Engineer:
    a) 8.0 Megapixel resolution or higher;
    b) 2 GB compact flash card;
    c) Camera case;
    d) USB cable with software.
14. Take every reasonable precaution to protect the office and its contents against fire and theft, or other damage. Indemnify the Engineer and its agents against loss by fire, theft and injury to the building, to the office or its contents.
15. Maintain the field offices along with all office equipment on each site at least until the successful completion of the respective 7 day trial run.

PART 3 - EXECUTION

3.01 Access:

A. Provide access to the site and work as required, in a proper and safe fashion.
B. Provide and maintain access to the existing pumping station in proper and safe fashion.
C. Illuminate the full site during the night.
D. Provide and maintain access roads, walkway crossings, ramps and construction runways as may be required for access to the work. Obtain approval from the Engineer before constructing temporary roads.

E. Provide construction warning signs along travelled roads as required or as requested by the Engineer.
F. Provide for mud removal and dust suppression, as required during the construction period.
G. Promptly repair damage to existing roads, walkways and other existing facilities.
H. Provide necessary warning sign boards for safety purposes.

3.02 Location of Temporary Facilities:

A. Coordinate the location of temporary facilities with the existing pumping station operations staff to the satisfaction of the Engineer.

3.03 Installation and Removal:

A. Provide temporary utilities including to the Engineer's office and equipment, facilities and controls to execute the work expeditiously.
B. Remove temporary utilities, facilities and controls after the successful completion of the respective 7 day trial run, unless otherwise directed by Engineer.

3.04 Storage of Material and Equipment:

A. Provide weather tight storage sheds with raised floors for the storage of equipment, as approved by the Engineer and/or equipment manufacturers. Supply to the Engineer all storage instructions from equipment suppliers well in advance of the scheduled delivery dates.
B. Handle and store products in a manner to prevent damage, adulteration, deterioration and soiling and in accordance with manufacturer's instructions.
C. Provide gates for both operational staff requirements as well as the Contractor's requirements.
D. Store products subject to damage from weather in weatherproof enclosures.
E. Store cementitious products clear of earth or concrete floors and away from walls.
F. Keep sand, when used for grout or mortar materials, clean and dry. Store sand on wooden platforms and cover with waterproof tarpaulins during inclement weather.
G. Store sheet materials, lumber etc on flat, solid supports and keep clear of ground. Slope to shed moisture.
H. Store and mix paints in a ventilated room. Remove oily rags and other combustible debris from the site daily. Take every precaution necessary to prevent spontaneous combustion.
I. Remove and replace damaged products to the satisfaction of the Engineer.
J. Do not use private property for storage purposes without the written permission of the BMC. Pay rental charges and damages associated with occupying private lands.

3.05 Temporary Site Enclosures:

A. Provide temporary weather tight enclosures and protection for exterior openings until permanent sash and glazing, exterior doors, louvers etc are installed.
B. Provide temporary enclosures for the work as required for weather protection.
C. Erect enclosures to allow accessibility for installation of materials and working inside the enclosure.
D. Keep temporary buildings in a clean and sanitary condition at all times and do not permit to become a health hazard or a nuisance to adjoining properties.

3.06 Temporary Shelter and Sanitary Facilities:

A. Provide and properly maintain in clean condition, a suitable privy or water closet for the Contractor's personnel as required by the Construction Safety Act.

B. Provide all required toilet supplies.

C. Provide and maintain drinking water and washing facilities as required by Construction Safety Act.

D. Provide shelter for workers.

E. Hutments for construction workers will not be permitted on site.

3.07 Water Consumption during construction stage and during Operation

B. Install water flow fixture namely taps, faucets, showers not exceeding a maximum flow of 10 litres per minute.

C. Install low flow urinals, not exceeding a consumption of 2 litres/flush

D. Install drip/sprinkler irrigation systems as appropriate, to avoid usage of open –ended hoses for landscape irrigation within project site.

E. Install temporary water bodies to capture 5% of rainwater which fall within site, which can be used for construction activities such as curing, dust control, landscaping purpose etc.

3.08 Temporary Fire Protection:

A. During the entire construction period, provide fire extinguishers in each construction shed and temporary office, as well as in other locations reasonably required, and all other fire protection necessary to protect the project and to comply fully with the requirements of insurance underwriters for the project and state authorities.

3.09 Temporary First Aid Facilities:

A. Provide and maintain the necessary first aid items and equipment as required.

B. Designate employees who are properly instructed to be in charge of first aid. Ensure that at least one such employee is always available on the site while work is being conducted. Comply with the Construction Safety Act and Regulations for Construction Projects.

3.10 Temporary Utilities:

A. Make arrangements for the supply of water, electrical power, gas, sanitary facilities and any other temporary services required during construction. Be responsible for all fees, permits and charges, including arrangements for all necessary applications, incurred throughout the construction period until after the successful completion of the respective 7 day trial run, unless otherwise directed by Engineer.

B. Permanent utilities installed under this Contract may be used for construction requirements provided that no guarantees are affected thereby. Make good any damage.

C. Operate equipment according to the requirements of the Construction Safety Code and Regulations for Construction Projects.

D. Arrange, pay for and maintain temporary electrical power supply as follows:

1. Temporary facilities for power, where required outside the plant, such as pole lines and underground cables with the approval of the local utility company.

2. Connection to the existing power supply system in accordance with the Electrical Safety Code. Provide meters and switchgear as required by the power supply company.

3. Electrical power and lighting system as installed under this Contract may be used for construction requirements provided that no guarantees are affected thereby. Make good any damage and replace all lamps which have been used for three months or longer.
4. If power is not made available by the authority, the Contractor shall make his own arrangement at his cost.

E. Arrange and pay for water required

1. Arrange and pay for water required for construction and other purposes (toilets, drinking etc.) from either the nearest municipal water main or other municipal source at the charged rates fixed by BMC. The adequacy of water shall not be guaranteed by BMC.
2. Make alternative arrangement for water with the approval of Engineer.

F. Pay the costs of temporary ventilation used during the course of construction, including costs of installation, operation, maintenance and removal of equipment. Provide temporary ventilation in enclosed areas, to:

1. Facilitate progress of work.
2. Protect work and products against dampness.
3. Prevent moisture condensation on surfaces.
4. Provide ambient temperatures and humidity levels for storage, installation and curing of materials.
5. Provide adequate ventilation to meet health regulations for safe working environment.
6. Prevent hazardous accumulation of dust, fumes, mist, vapors or gases.
7. Prevent harmful accumulation of hazardous substances into the atmosphere.
8. Ensure that the disposal of exhaust materials will not result in harmful exposure to persons or the environment.
9. Ventilate storage spaces containing hazardous or volatile materials.
10. Ventilate temporary sanitary facilities.
11. Remove harmful elements following the work processes.

G. Maintain strict supervision of operation of temporary ventilating equipment, to:

1. Enforce conformance with applicable codes and standards.
2. Enforce safe practices.
3. Prevent abuse of services.
4. Prevent damage to finishes.

3.11 Security:

A. Contractor to provide 24-hour security for his construction materials, equipment, tools and temporary facilities in full coordination with the BMC staff.

3.12 Traffic Control and Parking:

A. Observe load and truck route restrictions on the access roads and streets to be used.
B. Provide flagging and signage as necessary for traffic control.
C. Provide secure, rigid guardrails and barricades around deep excavations, open shafts, open stairwells, open edges of floors and roofs, as required by governing authorities.

3.13 Removal and Restoration of Temporary Facilities and Controls:

A. Remove temporary facilities and controls from the site on completion of the works, or as otherwise ordered in writing by the Engineer. Unless specifically stated otherwise in the Contract Documents, maintain BMC's ownership over the temporary facilities including furnishings.

B. As each portion of the work is completed, as determined by the Engineer, restore disturbed areas, roadways, fences, building, etc. equal to or better than the initial condition and clean up the construction area as instructed by the Engineer.

C. Leave clean and in good order, roads, parking areas, walkways, turfed, seeded and other areas disturbed by the construction. Failure to make satisfactory progress in the execution of this work within forty-eight hours of receipt of written notice from the Engineer may result in the Engineer having the surplus material removed, or re-grading any area or performing any work necessary to leave the site in a satisfactory condition and having the costs deducted from payments due under the Contract.

END OF SECTION 01009

SECTION 01010 SAFETY REQUIREMENTS

PART 1 - GENERAL

1.01 Reference:

A. Section 01000 applies to and governs the work of this Section.

1.02 Construction Safety Measures:

A. Observe and enforce construction safety measures required by the latest edition of the following documents: Indian Standard Safety Codes, the National Building Code, 2005, Maharashtra Factory Act 1948 and Rules 1963 and their amendments, other applicable safety regulations and Municipal statutes and authorities.

B. In the event of conflict between any provisions of the above authorities, the most stringent provision governs.

PART 2 - PRODUCTS

2.01 There are no products in this section.

PART 3 - EXECUTION

3.01 General Requirements:

A. Provide a sign board in English, Hindi and Marathi indicating work in progress, hard hat area and restricted entrance at all entrance gates.

B. Provide access to existing facility at all times so that BMC can run the existing facility during construction and refurbishment period of pumping station and other related structures.

C. Mark hazardous areas as NO SMOKING ZONE.

3.02 Excavation:

A. Cordon off excavated areas by providing reflective tape.

B. Ensure that workers working in excavated areas wear hard hats.

C. Stockpile excavated material sufficiently away from edges of excavations so that caving does not take place. Ensure that heavy equipment is parked away from edge of excavations.

D. For excavation exceeding 600 mm in depth must be sloped at 45^{o} or else shoring to be provided to support sides.

E. If the required side slopes cannot be maintained, vertical excavation can be done by providing shoring and strutting. The shoring must be designed by a competent engineer and submitted to the Engineer for approval prior to excavation.

F. While dewatering, water must be discharged sufficiently away from the excavated area to avoid unsafe conditions and to the satisfaction of the Engineer.

3.03 Construction:

A. Ensure that workers, supervisors and engineers working at site wear hard hats.

B. Ensure that staff working at height wear suitable fall arrest equipment.

C. Ladders used must be of sufficient strength to take up to 125kg load. For further precaution the pitch at which a floor ladder is used shall be 1 horizontal: 4 vertical.

D. Walk ways on all floors must be clearly marked and must always be kept free of materials.

E. All openings on higher floors must be barricaded.

F. While lifting materials ensure area beneath is kept clear of people.

G. Supports below slabs must be checked for verticality, rigidity and bracing if height is more than 3.0m.

H. Temporary scaffolds erected for brick work, plaster etc must be adequate to take load of bricks, mortar and workmen. Overloading is not permitted.

I. For plastering on external surfaces, double scaffolding shall be erected and properly braced with the building.

J. Contractor shall provide guardrails, gang planks, railings, barriers, lights, signs and other equipment or materials that are required for the safety of people who are working in project area.

K. The site must be kept clean at all times; debris to be removed on a daily basis.

L. Nominate safety engineer to assist in implementing safety precautions.

M. Light entire site when working at night.

N. Safety engineer must hold periodical safety meetings with workers and field supervisors to guide workers about necessity of safety.

O. Fire fighting drills and safety kit must be used as per section 01009.

P. Any accident occurring at site must be reported to the Engineer within 24 hrs of its occurrence and the insurance company informed.

Q. When working on public roads, the Contractor shall provide personnel for helping police in traffic management.

R. During the period when construction is in progress on roads, the Contractor to provide barricades to ensure no unauthorized person enters the area of excavation.

S. Provide warning lights at night to warn vehicles regarding excavation and provide proper security.

T. Provide medical kits at site level upon mobilization and identify nearby ambulance call-services to meet any emergency requirements.

3.04 Fabrication and Erection:

A. All welders must use safety glass and other safety gear.

B. Lifting ropes, chains and slings must be tested with double the loads it is intended to lift.

C. Safety belts must be used by riggers.

D. Wire ropes with broken strands must not be used.

3.05 Electrical:

A. All cables used during construction must be flexible and insulated.

B. All sockets, switches and cutouts to be weather proof.

C. Connection to all moving equipment such as vibrators, pumps etc must be properly insulated with double earthing.

D. Main switches to be housed in waterproof box.

E. Frayed and joined wire and cables to be removed from site immediately.

F. Over loading in all cases to be avoided.

G. Shield and mark live plant “live 415 volts” or with appropriate voltage.

3.06 Fire Safety:

A. All timber waste, oil rags and other such fire hazardous material to be disposed of daily from site.

B. Arrange mock fire safety drills at site every 3 months and arrange and communicate evacuation procedures.

3.07 Hazardous Areas:

A. Clearly demarcate hazardous areas.

B. All authorized persons entering the area to have proper protective gear.

C. Before entering manholes or wet wells, take proper precautions by ventilating the area or providing oxygen masks.

D. Use only non-sparking tools in potentially explosive areas.

END OF SECTION 01010

SECTION 01011 ENVIRONMENTAL PROTECTION AND CONTROL

PART 1 - GENERAL

1.01 Reference:

A. Section 01000 applies to and governs the work of this Section.

1.02 Work Included:

A. The Contractor shall be responsible for taking all required Environmental Measures to meet or exceed the requirements of environmental legislation and regulations or revalidation, including amendments in force during the contract period. The Contractor shall not be entitled to claim for any expenses incurred and for extension of time for completion of the project.

B. Construct this project in accordance with construction and restoration guidelines established by the Ministry of Environment and Maharashtra Pollution Control Board through Work Permit Regulations.

C. In case of conflict or discrepancy in the regulatory requirements, the more stringent requirements will be applied.

1.03 Protection of Environment:

A. Take all reasonable steps to protect the environment on and off the site and to avoid damage or nuisance to persons or to property of the public or others resulting from pollution, noise or other causes arising as a consequence of the work.

B. Abide at all times by all existing and future enactments, rules made there under, regulations, notifications and by-laws of the State or central government, or local authorities.

C. Salient features of some of the major laws that are applicable are given below:

1. The Water (Prevention and Control of Pollution) Act, 1974.

   Prevention and control water pollution and maintain and restore wholesomeness of water in accordance with this Act
   The Contractor shall not release to surface waters anything which is harmful or injurious to public health or to domestic, commercial industrial, agricultural or other legitimate uses, or to the life and health of animals or plants or of aquatic organisms.

2. The Air (Prevention and Control of Pollution) Act, 1986.

   Protect and improve the environment and for matters connected therewith, and the prevention of hazards to human beings, other living creatures plants and property.

3. The Public Liability Insurance Act, 1991.

   Provide public liability insurance for the purpose of providing immediate relief to any persons affected by accident occurring while handling hazardous substances and for matters connected herewith or incidental thereto. Under the Environment (Protection) Act 1986 and other applicable laws, and exceeding such quantity as may be specified by notification by the central / state/ Government/ local authority.

PART 2 - PRODUCTS

A. Provide equipment and materials required to protect the environment.

PART 3 - EXECUTION

3.01 Enforcement:

A. Protection of the environment is of great importance during the work.

B. Progress payments will not be made to the Contractor while any requirements for environmental protection are outstanding.

C. Take immediate action to correct environmental deficiencies at the direction of the Engineer.

D. In the event that deficiencies are not corrected in a timely manner, the Engineer may take the necessary corrective action and may deduct the cost thereof from payments otherwise due under the Contract.

3.02 Disposal of Water:

A. Provide temporary ditches and/or sedimentation ponds of sufficient capacity to contain site run-off and truck wash water. Provide ditches and ponds with silt traps, silt fences, straw bales and rock check dams as required.

B. Discharge settled water though storm water drains in the premises to prevent water logging in the area or the water may be stored in a water tank temporarily for settlement and reuse for washing, settling of dust etc.

C. Do not pump or drain water containing deleterious materials into waterways and sewers. Intercept concentrated run-off from un-stabilized areas and divert to a temporary ditch or other areas under sheet flow conditions. Pump water from excavations to an upstream location in any temporary ditch to allow maximum settling prior to discharging to a natural watercourse.

3.03 Pollution Control:

A. Maintain temporary erosion and pollution control features installed under this contract.

B. Control emissions from equipment such as diesel generators etc to local authorities' emission requirements.

C. Cover or wet down dry materials and rubbish to prevent blowing dust and debris. Provide dust control for temporary roads.

D. Maintain construction equipment properly to minimize exhaust emissions.

E. Clean construction equipment prior to entering public roadways to avoid spilling of construction debris and mud. Collect construction debris in a designated area for ultimate disposal off site.

3.04 Adjacent to Waterways:

A. Do not operate construction equipment in waterways.

B. Do not dump excavated fill, waste material or debris in waterways.

C. Design and construct temporary crossings to minimize erosion to waterways.

D. Do not float logs or construction materials across waterways.

E. Avoid spawning beds when constructing temporary crossings of waterways.

3.05 Dust and Mud Control:

A. Take such steps as required to prevent dust and mud nuisances resulting from construction operations within the site. Carry out dust control practices at all locations on site and on adjacent roads.

B. Transport excessively dusty materials in covered vehicles.

C. Where the work requires saw-cutting of asphalt or saw-cutting or grinding of concrete, use blades and grinders of the wet type together with sufficient water to prevent the incidence of dust.

D. Ensure that all debris and mud upon travelled roadways resulting from construction operations or the delivery of materials to the site are removed at the end of each day's operation.

3.06 Noise Control:

A. Ensure that vehicles and equipment are equipped with efficient muffling devices to minimize noise levels in the project area. Provide noise barriers as required to limit the noise level at site boundaries in accordance with local by-laws.

B. Establish and maintain site procedures consistent with the objective that noise levels from the construction area be minimized and in accordance with local by-laws.

C. During construction ambient noise levels should conform to residential standards as prescribed in the relevant code both during day and night. Incremental pollution loads on the ambient air and noise quality should be closely monitored during construction phase. Adequate measures should be made to reduce ambient air and noise level during construction phase so as to conform to the stipulated standards by CPCB/MPCB.

3.07 Construction Wastes:

A. Provide sufficient suitable refuse containers throughout the site to receive and control construction wastes. Keep containers closed to prevent contents from blowing around site.

B. Install colour coded waste bins in all public areas to enable segregation of waste, such as paper, plastic, organic etc. within the site.

3.08 Equipment Maintenance and Refueling:

A. Undertake a detailed review of the construction site to plan access routes and fuelling areas. Do not refuel or maintain equipment in or adjacent to watercourses. Establish suitable fuelling and maintenance areas subject to the approval of the Engineer and restrict maintenance and fuelling to these areas.

B. Submit procedures for the interception, rapid clean-up and disposal and reporting of any spillages that do occur to the Engineer for review prior to starting work. Keep materials required for clean up of fuel spillages readily accessible on site.

C. Generators, cranes, backhoes or shovels may be fuelled at other than the designated fuelling areas. However, do not refuel equipment within 30 metres of any watercourse. This requirement may be relaxed at the discretion of the Engineer if no-spill fuelling facilities are used.

3.09 Non-Maintenance Related Spills:

A. Non-maintenance related spills include those that occur due to mishandling of fuels during the fuelling process, failure of hoses or other components on equipment.

B. Submit a contingency plan for dealing with such occurrences to the Engineer for approval.

C. The plan must describe in detail the action to be taken and the persons and the agencies to be notified in the event of such a spill, including a spill reporting procedure.

3.10 Fires:

A. Do not light fires or burn rubbish on the sites.

3.11 Tree Protection:

A. Protect trees and shrubs on the site, which are not specifically designated to be removed. Isolate trees from the construction area with protective fences erected along the tree drip line.

B. Do not pile excavated material around the base of trees.

C. Repair any limbs removed or any scars caused by machinery and paint with approved dressings.

3.12 Cleaning and Disposal of Wastes:

A. Dispose of all waste and rubbish off site. Do not bury waste on site.

B. Do not dispose of waste into waterways or sewers.

C. Clean the sites during the course of the work, before the start-up of a part of the works, and at completion, as required to the satisfaction of the Engineer.

D. Conduct cleaning and disposal operations to comply with local ordinances and pollution control laws.

E. Store volatile wastes in covered containers which if kept open may create hazardous conditions.

F. Prevent accumulation of wastes which may create hazardous conditions.

G. Maintain the project site and adjoining public properties free from accumulation of waste materials and rubbish.

H. Provide on-site dump containers for collection of waste materials and rubbish.

I. Provide adequate ventilation at all times when volatile or noxious substances are used.

J. Construction debris to be disposed at disposal sites identified by the contractor after taking necessary permissions and taking BMC approval. Cost to be borne by the Contractor.

K. During construction allocate dedicated area for segregation and storage of construction waste material. Reuse 50%(by volume or weight) of such waste either in-situ or ex-situ. Identify and sell or donate, segregated construction waste for recycle or reuse.

END OF SECTION - 01011

SECTION 01012 PROJECT SIGNBOARDS

PART 1 - GENERAL

1.01 Reference:

A. Section 01000 applies to and governs the work of this Section.

PART 2 - PRODUCT

2.01 Construction Signs:

A. Construction signs at each site: 1.2 m x 2.4 m, of wood frame and minimum 20 mm plywood construction painted with exhibit lettering produced by a professional sign painter.

B. Indicate on signs:

1. The name of BMC with Logo of the BMC in colour
2. Project Name and other information of a design style established by the BMC.
3. Main Contractor Name and Contact Information
4. The sign board shall be in English, Hindi and Marathi.

PART 3 - EXECUTION

A. Produce and deliver the project sign boards to the site. Erect sign boards in the locations designated by the Engineer, within one month of signing the Contract.

B. Maintain sign boards in good condition for the duration of the work. Clean periodically to the satisfaction of the Engineer.

C. Ensure that no other signs or advertisements, other than warning signs, are displayed on site.

D. Remove project sign boards at the end of the Contract or when directed by the Engineer.

END OF SECTION 01012

SECTION 01013 MATERIAL AND EQUIPMENT

PART 1 - GENERAL

1.01 Reference:

A. Section 01000 applies to and governs the work of this Section.

1.02 Work Included:

A. This Section specifies the requirements for material and equipment to be incorporated in the works.

B. The requirements specified in other sections of these Specifications modify some of the items of this Section for that particular application.

1.03 Quality:

A. Provide materials, products and equipment of the quality specified.

B. Defective products, whenever identified prior to the completion of the work, will be rejected, regardless of previous inspections. Inspection does not relieve responsibility but is a precaution against oversight or error. Remove and replace rejected products and be responsible for delays and expenses caused by rejection.

C. Damaged Products

1. The Contractor shall notify the Engineer in writing in the event that any equipment or material is damaged.
2. Repairs to damaged products shall not be made without prior approval by the Engineer.

D. In case of any dispute arising to the quality or fitness of products, the decision rests strictly with the Engineer based upon the requirements of the Contract Documents.

PART 2 - PRODUCTS

2.01 Fastenings - General:

A. Provide metal fastenings and accessories in the same texture, color and finish as the base metal in which they occur, unless specified otherwise. Prevent electrolytic action between dissimilar metals. Use non-corrodible, stainless steel fasteners, anchors and spacers for securing exterior work, unless other material is specified.

B. Anchors shall be within limits of load bearing or shear capacity and ensure that they provide positive, permanent anchorage. Wood plugs are not acceptable.

C. Keep exposed fastenings to a minimum, space evenly and lay out neatly.

D. Fastenings which may cause spalling or cracking of material to which anchorage is made are not acceptable.

2.02 Fastenings - Equipment:

A. Use fastenings of standard commercial sizes and patterns with material and finish suitable for service.

B. Use heavy hexagon heads, semi-finished unless otherwise specified. Use AISI Type 304 stainless steel for exterior areas. Use AISI 316 Type stainless steel for items in contact with chemicals or sewage.

C. Bolts may not project more than one diameter beyond nuts.

D. Use plain-type washers on equipment, sheet metal and soft gasket lock-type washers where vibration occurs and resilient washers with stainless steel.

2.03 Lubricants and Charts:

A. Provide lubricants and maintenance charts as required, for a complete, operational system.

B. Provide hot-plasticized charts suitable for wall mounting.

2.04 Special Tools and Templates:

A. Provide templates and special tools required for the installation and operation of any part of the system. Provide such templates and tools complete with a detailed list thereof. Hand over templates and tools to the BMC at the end of the O&M period.

B. Provide special tools required for the routine maintenance of equipment items supplied under this Contract.

PART 3 - EXECUTION

3.01 General:

A. The Contractor shall be responsible for ensuring that products supplied under the Contract comply with the requirements of the Contract. Ensure that suppliers of products comply with the specified requirements. If a supplier fails to comply with specified requirements, be responsible for ensuring that the requirements of the Contract have been fulfilled.

B. Where equivalent is acceptable, give preference to equivalent products of local suppliers who meet the requirements.

C. Use only new products and material of suitable quality unless otherwise specified, and suitable for the specific service. At the request of the Engineer, provide evidence as to type, source and quality of products to be supplied.

D. Have the equipment conform to the requirements of the applicable standards.

E. If there is question as to whether any product or system is in conformance with applicable standards, the Engineer reserves the right to have such products or systems tested to prove or disprove conformance.

F. When material or equipment is specified to a standard or performance specifications, at request of the Engineer, obtain from the manufacturer an independent laboratory testing report stating that the material or equipment meets or exceeds the specified requirements

G. Provide ancillary parts, fittings, connections, piping, nuts and bolts, gaskets, wiring, and other items necessary to properly install the component and equipment into a complete system.

H. Refer to technical specification of mechanical, electrical and I&C from Volume II.

3.02 Availability:

A. Immediately upon signing the Contract, review product delivery requirements and anticipate foreseeable supply delays for any items, including those items supplied by the BMC. Notify the Engineer of potential or real delays in supply of products, in order that substitutions or other remedial action may be authorized in ample time to prevent delay in performance of the Work.

B. In the event of failure to notify the Engineer at commencement of the Work and should it subsequently appear that the Work may be delayed for such reason, the Engineer reserves the right to substitute more readily available products of similar character, at no increase in contract price.

3.03 Delivery and Storage:

A. Store and maintain materials in accordance with suppliers' instructions. Provide copies of storage instructions to the Engineer prior to delivery.

B. Inspect material and equipment upon delivery in the presence of the Engineer, for loss or damage in transit and notify the agent of the carrier of any loss or damage to the shipment per Section 01008.

C. Leave intact all manufacturers' labels and seals.

D. Prevent damage, adulteration and soiling of materials during delivery, handling and storage.

E. Immediately remove rejected materials from the site.

3.04 Manufacturer's Instructions:

A. Unless otherwise indicated in the Specifications, install or erect products in accordance with manufacturer's instructions.

B. Provide cores, through walls and floors, for new piping and appurtenances, based on approved equipment shop drawings and field measurement. Do not rely on labels or enclosures provided with products. Obtain written instructions directly from manufacturers.

C. Notify the Engineer, in writing, of conflicts between the Specifications and manufacturer's instructions, so that the Engineer may establish the course of action.

D. If products are installed or erected without complying with the manufacturer's requirements or the Specifications, remove and reinstall products properly and to the satisfaction of the Engineer.

END OF SECTION 01013

SECTION 01014 COMMISSIONING OF WORKS

PART 1 - GENERAL

1.01 Reference:

A. Section 01000 applies to and governs the work of this Section.

1.02 Work Included:

A. The work included in this section covers – Pre-commissioning and commissioning activities not limited to following:

1. Supply of consumables for commissioning
2. Cleaning and visual Inspection
3. Leak test for water retaining structures
4. Preparation of check list and completion
5. Testing of mechanical and electrical equipment
6. Hydro test of pipelines
7. Flushing of pipe lines
8. Pipe disinfection for drinking water supply
9. Operability test
10. Start-up procedures
11. Commissioning
12. Trial runs

B. The pumping stations shall be considered successfully commissioned after trouble free operation of all equipment for at least 7 days.

PART 2 - PRODUCT

2.01 Equipment Identification Tags:

A. Ensure that all items of equipment identified with a bubble or a code name on the process and instrumentation diagram including flow meters, automatic valves, switches, level sensors, analyzers, manually operated equipment and other items of equipment identified on the process, mechanical and electrical drawings are identified with a tag.

PART 3 -EXECUTION

3.01 Consumables for Commissioning:

A. Provide all lubricants required for the equipment. Provide initial fills of consumables to conduct testing, trial run and commissioning including 7 days operation of the pumping station.

3.02 Cleaning and Visual Inspection:

A. Before start-up, ensure that civil structures, equipment, piping conduits etc are properly cleaned and all debris and foreign matter removed. Clean, brush, flush with water as required to provide clean work.

B. Vacuum clean interior building areas when ready to receive finish painting, and continue vacuum cleaning on an as-needed basis.

C. Schedule cleaning operations so that dust and other contaminants resulting from cleaning process will not fall on wet, newly painted surfaces.

D. Use only cleaning materials recommended by the manufacturer of the surface to be cleaned and as recommended by cleaning material manufacturer.

3.03 Leak Test for Water Retaining Structures:

A. In addition to the structural test of structures, as given in IS: 456(latest version), the tanks shall also be tested for water tightness at full supply level as described in IS 3370 (Part I)(latest version).

1. In the case of tanks whose external faces are exposed such as elevated tanks, the requirements shall be deemed to be satisfied if the external faces show no signs of leakage and remain apparently dry over the period of observation of seven days after allowing a seven day period for absorption after filling.
2. The structure should be cleaned and initially filled to the normal maximum level with the specified liquid at a uniform rate of not greater than 2 m in 24 h. When first filled, the liquid level should be maintained by the addition of further liquid for a stabilizing period while absorption and autogenous healing take place. The stabilizing period may be 7 days for maximum design crack width of 0.1 mm or 21 days for 0.2 mm or greater. After the stabilizing period, the level of the liquid surface shall be recorded at 24 h intervals for a test period of 7 days. During this 7 day test period, the total permissible drop in level, after allowing for evaporation and rainfall, should not exceed the maximum of 1/500th of the average water depth of the full tank and 10 mm or another specified value, mutually agreed between the parties to contract. In case of underground tanks whose top is covered, the total permissible drop in the surface level over a period of 7 days shall not exceed 20 mm.
3. If the structure does not satisfy the conditions of test, and the daily drop in water level is decreasing, the period of test may be extended for a further seven days and if specified limit is then reached, the structure may be considered as satisfactory.

B. Conduct leakage test prior to the commencement of lining/painting and backfilling operations.

C. Repair leaks and retest as required of IS 3370 (Part I).

3.04 Preparation of Reference Forms and Completion:

A. After the majority of installation work is complete, the Contractor will prepare and submit the relevant Reference Forms in accordance with Section 01017.

B. These forms shall be submitted not later than four weeks prior to the commencement of commissioning.

C. The Contractor to ensure that the Reference Forms are completed to the Engineer's satisfaction.

3.05 Testing of Mechanical and Electrical Equipment:

A. Test mechanical equipment, including valves, gates, plumbing units etc for proper operation, leaks etc and adjust, as required, in advance of the main commissioning of the pumping stations.

B. Test pumps, motors and other machinery for proper function within the respective sub-systems in which they operate. Demonstrate to the Engineer or its representative that the systems function as specified.

C. Check rotating equipment and test for noise and vibration as specified.

D. Test and adjust ventilation and air conditioning systems as specified in division 15.

E. Test and adjust electrical systems as required by applicable codes and as specified in division 16.

F. Test and adjust the instrumentation and control system in conjunction with the equipment supplier, including all pressure switches, sensors, level detectors etc and adjust as required.

3.06 Hydro Test of Pipe Lines:

A. Do not pressure test piping against existing or new valves. Provide blind flanges.

B. Do not install in-line instruments/device during hydro test.

C. Hydro test piping system for pressure and leakage as specified in divisions 2 and 15 of these Specifications.

3.07 Flushing of Pipelines:

A. Before operating a piping system, thoroughly flush with water to remove construction debris and dirt from the system to the satisfaction of the Engineer. Be responsible for the satisfactory disposal of water used in flushing in accordance with Section 01011.

3.08 Pipe Disinfection for Drinking Water Supply:

A. Disinfect potable water piping in accordance with the AWWA 651-99, Disinfection of Water Mains, referred to by the Safe Drinking World Health Organisation Water Standards.

B. The standard also applies to existing mains opened by design or accident, furnish required materials, labour, temporary connections, etc and arrange for bacteriological testing after final flushing and pressure testing. If bacteriological testing shows incomplete disinfection, repeat the procedure.

C. Do not dispose of the disinfection water to streams or sewers until the total residual chlorine is reduced to 0.002 mg/l.

3.09 Operability Test:

A. Where specified, direct each equipment supplier to check installation and assist in commissioning of their respective equipment before it is operated.

B. Ensure that factory-trained technical representative provides the services stated in the relevant specification. Ensure that each supplier furnishes to the Engineer, a letter or certificate stating that the qualified representative has found the installation to be to their satisfaction.

C. Ensure that the supplier provides the services for a period as required to commission the said equipment. Ensure the equipment operates to his satisfaction. Submit the certificate to indicate the tests performed and the results to Engineer.

D. If the equipment is operated before the supplier has commissioned it, be responsible for any damage caused to the equipment by such premature operation.

E. The Engineer may require full field testing of any item of equipment. Contractor shall comply with this requirement at no cost to the MCGM.

F. Notify the Engineer at least 48 hours in advance of planned start up of any equipment to allow the Engineer and other representatives of the BMCto attend. Failure to do so may result in a second start up at the Contractor’s expense.

G. All equipment shall be operated with water for minimum 24 hrs before taking sewage in the pumping station.

3.10 Start –up Procedure:

A. Submit copies of the proposed Start-up and Commissioning Schedules for equipment units and systems in accordance with section 01007, four weeks prior to the start of the related testing for approval by the Engineer. Revise the schedule based on the Engineer's review and resubmit copies of the approved schedule in accordance with Section 01007.

B. Include in the Start-up Commissioning Schedule including the following items as a minimum:

1. Time and date of each test
2. A list of equipment to be tested and parties to be present.
3. Tests that will be performed for each related piece of equipment.
4. Test procedure
5. Test plan

C. Begin testing on time based on the approved test schedule.

D. For start-up activities in confined space locations, provide at least two Contractor staff that are trained and certified in confined space entry procedures. Provide necessary confined space entry equipment.

E. Before starting processes or equipment, notify the Engineer, and ensure that isolation valves etc are properly adjusted to prevent inadvertent and /or improper operation. Also, observe proper precautions not to create excessive surges, water hammer overflows, and vibrations to the detriment of the works.

F. Have all required personnel on site, including manufacturers and instrumentation controls supplier's representatives as and when requested by the Engineer.

G. Check equipment for soundness and for correctness of setting, alignment and relative arrangement of various parts of the systems. Provide additional start-up tests as specified in specific equipment sections.

H. Continue start-up procedure until each individual component item or system demonstrates all operational features and until controls function while in automatic modes.

3.11 Commissioning of Pumping Stations:

A. Initiate commissioning by taking sewage in the pumping station and be responsible for the mechanical, electrical and instrumentation and control work.

B. Operate the entire pumping station for a period of seven (7) calendar days to the satisfaction of Engineer. Continuous 7-day operation is required as part of completion of commissioning, before the issuance of the Trail Run Certificate for the completion of the particular pumping station.

C. The Engineer and the BMCwill only provide assistance during this period. Ensure that all required staff from each discipline are present during commissioning period and available on call as required to rectify any discrepancies or omissions to the satisfaction of the Engineer. Note that the BMCor the Engineer will not offer nor be responsible for any manpower or advice to the Contractor during this period except as noted above. Any major breakdown of any part of the plant that affects the process will require the re-start for 14 day period.

D. Correct deficiencies found during the 30 days operation. Make correction and adjustments to equipment operation to the satisfaction of the Engineer.

3.12 Trial Run:

A. In the 7 day commissioning period, there shall be trial run for each item of equipment for minimum 72 hrs.
B. During trial run, operate equipment at design flow/ design condition.

END OF SECTION 01014

SECTION 01015 OPERATION AND MAINTENANCE

PART 1 -GENERAL

1.01 Reference:

A. Section 01000 applies to and governs the work of this Section.

B. Refer to Section – 01016 – Contact Closeout

1.02 Work Included:

A. Operate, maintain and monitor all the pumping stations including PLCs and SCADA systems, including it's piping and overflow for 36 months after successfully completing the commissioning and trial run. The scope of work includes but shall not be limited to the following:

1. Contractor shall be responsible for overall operation and maintenance of complete pumping stations including its piping, emergency overflow by-passes, administration buildings, workshop, electrical rooms and other site works.
2. The Contractor shall be responsible for maintenance and all repairs of civil structures, equipment, plant machinery, piping, electrical, instrumentation and control systems.
3. Ensure un-interrupted and trouble free operation of the pumping stations.
4. Ensure proper operation of EOT cranes, other mechanical equipment, electrical and instrumentation appliances including PLCs & SCADA systems.
5. Record and inform the Engineer of all overflow events from the pumping station.
6. Record and inform the Engineer of all accidents.
7. Prepare and implement, in consultation with the Engineer, an effective preventive maintenance programme for the pumping stations, rising mains, bypasses and administration buildings.
8. Be responsible for preventive maintenance including break-down maintenance.
9. All incidental work connected to the regular operation and maintenance of the facilities.
10. Be responsible for keeping updated records for equipment and maintaining every day logbook relating to running of machinery, consumption of energy and other consumables and various analyses performed and maintain the operation and maintenance data for the following:
    a) Daily status record of the pumping stations, rising mains and Overflow
    b) Daily flow record
    c) Operation records of mechanical screens
    d) Operation record of pumps
    e) Operation record of gates
    f) Operation record of EOTs
    g) Maintenance record including consumables and spares used
    h) Field mounted instrument readings

i) PLC and SCADA system records

j) CCTV records

k) Any other allied works required by Engineer

11. Data shall be made available for review as and when requested by the Engineer.

B. Submit a monthly report to the Engineer about the operation and maintenance of the facilities indicating the manpower, electric power and consumables, problems faced and rectified.

C. Maintain all pumping station units and other civil structures on the premises, including the boundary walls, in a sturdy manner.

D. Be responsible for proper upkeep of administrative and other buildings.

E. Be responsible for timely removal and safe disposal of the screenings and other garbage from the pumping station site, including transportation, loading and unloading. Obtain approval for the location of the disposal of the screenings from the Engineer.

F. Be responsible for maintenance of street lighting, terminal blocks, earthing, cabling etc.

G. Be responsible for the maintenance of the planting land landscaping on the sites.

H. Maintain the sewerage and drainage systems, roads and pathways in good condition within the pumping station premises.

I. Be responsible for the security of the premises.

J. Keep the sites including the administration buildings tidy and clean.

K. Hand over the pumping stations, rising mains, Emergency Overflow, administration building and site works to the Employer after expiry of the operation and maintenance part of the Contract in an acceptable operating condition.

L. Spare Parts

1. All spares required during O&M period shall be stored by the contractor at his own cost to avoid unnecessary equipment downtime.

2. Spares for 5 years as listed in price schedule shall be provided by Contractor before commissioning of the new works. These spares shall not be used in commissioning or during two years of O&M by Contractor.

3. Deliver the spares after the completion of erection but before the start of pre-commissioning of plant along with technical leaflets and details. Spare parts shall be identified in the appropriate operation and maintenance manual drawings with part numbers. The list of spare parts including part numbers shall be submitted to the Engineer with the spare parts.

4. Provide spare parts new, unused and strictly interchangeable with the parts for which they are intended to be replaced, treated and packed for long storage under the prevailing climatic conditions.

5. Each spare part shall be clearly labelled on the outside of its packing with its description, number and purpose. When more than one spare is packed in a single package, a general description of its contents shall be shown on the outside and a detailed list enclosed.

6. All packages shall be marked and numbered in an approved manner for the purpose of identification.

1.03 General Terms and Conditions:

A. The Operation and Maintenance period shall be 36 months from the date of successful completion of trail run the relevant pumping station.

B. The Employer shall be responsible for paying the electricity bills during the O&M period.

C. The Contactor shall be responsible for providing all consumables, lubricants and spares required during the O & M period.

D. The Contactor shall be responsible for providing continuous staffing for operation, maintenance and monitoring of the pumping stations, rising mains, overflow, site works and administration buildings on each site.

E. The Contactor shall provide trouble-shooting services and emergency operation for the plant and equipment.

F. The Contactor shall take all necessary measures to avoid flooding of the pumping stations.

G. In the event of any damage, theft of property or injury or loss of life due to negligence on the part of Contractor, the Contractor shall be solely responsible and liable for compensation and damages.

H. Ensure that manufacturers / supplier's technical support shall be available within the time as specified by Engineer, during the O & M period.

I. The Contactor shall maintain security of the premises round-the-clock shall arrange manpower to prevent theft and malicious damage. No persons shall be allowed to enter the premises except municipal staff, officials and representatives of the Engineer without permission. Organised visits shall require written permission from the Engineer.

J. The Engineer shall have access to the sites at all times during the O & M period.

K. The Contactor shall observe all safety rules and regulations corresponding to electricity, factory act, fire safety rules and building codes and be responsible for all consequences and costs resulting from non-observance or oversight of the rules and regulations.

1.04 Financial Terms and Conditions:

A. Electricity charges for the operation of the pumping stations shall be borne by the Employer. The electricity shall be used only for the operation of the plant.

B. The cost of spares and consumables required during the O&M period will be borne by the Contractor.

C. The screenings from the sewage pumping stations shall be disposed to the land fill site (Devenar or Kanjur land fill site), designated by the Engineer.

D. All tools and equipment required for the proper operation and maintenance of the pumping station shall be provided by the Contractor.

E. All property and equipment in the premises shall be the property of Employer and shall not be rented, moved elsewhere or misused.

1.05 Deployment of Staff during Operation and Maintenance Period:

A. The Contactor shall provide the staffing to fully operate and maintain the pumping stations as per the specified qualifications stated below. The Contactor shall submit to the Engineer the list of staff to be employed with their detailed qualifications prior to the commencement of the Operation and Maintenance period.

B. During the O & M period and prior to handover of the facilities, the Contactor shall train the Employer's staff in all aspects of operation and maintenance of the pumping stations.

C. There shall be three shifts in a day.

Sr. No.	Qualification Required	Post	Total No. Required		Experience
1	Electrical / Mechanical Graduate	Manager	General shift	1	10 years in O&M of Pumping Station
2	Mechanical / Electrical Diploma Holder	Engineer at Pumping station	Three shift	4	7 years in O&M of pumping station with 2 years experience in HT system
3	ITI Certificate (Fitter and Electrician)	Operators	Three shift	4	5 years with 2 years experience in HT system
4	Tech. Skilled	Maintenance unit	Fitter and Electrician (general shift)	2	5 years
5	Skilled	Helpers	Three shift	4	3 years
6	Unskilled	Watchmen	Three shift	4	
7	Unskilled	Labourers	Three shift	4	
8	Unskilled	Sweepers and gardeners	General shift	1	

D. The Contactor shall provide all uniforms, safety equipment and personal protection equipment to operating and maintenance staff.

1.06 Performance Tests:

A. Performance tests shall be carried out over a continuous 72-hour period in the last month of the O & M period. During the tests, each pump shall be operated at its design flow. All equipment will be operated in automatic mode. All mechanical and electrical equipment, instruments and SCADA systems etc shall be demonstrated to be in proper operating condition.

B. In the case of any interruptions, the tests will not be accepted and will be repeated. Prior to repetition of tests, the defects shall be rectified, so that all equipments/ systems are in good operating condition.

1.07 Training:

A. The Contractor shall carry out the training of Employer's Personnel in the operation and maintenance of the Works. The programme and scheduling of the training shall be agreed with the Employer, and the Contractor shall provide experienced training staff, and all training materials. The Employer shall be responsible for nominating and selecting suitable personnel for training.

B. The Contactor shall provide instruction to the Employer's operating and maintenance staff in the proper operation and maintenance of the pumping station equipment and shall ensure that each major equipment supplier provides a minimum of two training sessions on their respective equipment. Training sessions shall be of the duration as specified in the individual equipment specifications.

1.08 Taking Over and Performance Certificates:

A. The conditions for issuing the certificates as detailed in the Conditions of Contract shall comprise:

1. The Engineer shall issue one Taking-Over Certificate after the successful completion of commissioning of each pumping station. This date of this certificate will constitute the start date of the 24 month operation and maintenance period.

2. The final Taking-Over Certificate will be issued at the end of the O & M period, after operation and maintenance of the pumping station and the successful completion of a continuous 72 hour period to the satisfaction of Engineer. During this period the Employer's staff may be present at the pumping stations and will take over plant after the 72 hour operation. This date of this certificate will constitute the start date of the 12 month defects notification period.

PART 2 - PRODUCTS

A. Submit all required documents as specified above in this Section.

B. Documents as specified in Section 01016 are updated and have been submitted

PART 3 - EXECUTION

A. Operate and maintain the systems for 36 months after successful commissioning of pumping station.

END OF SECTION 01015

SECTION 01016 CONTRACT CLOSEOUT

PART 1 -GENERAL

1.01 Reference:

A. Section 01000 applies to and governs the work of this Section.

1.02 Works Included:

A. This section details the requirements that the Contractor shall fulfill prior to the issue of the Inspection and Taking-Over Certificates. Each pumping station shall necessarily be taken over in various stages as follows:

1. On the approval of the relevant O&M documents and on successful commissioning and 7-day trial operation of the pumping stations to the satisfaction of the Engineer. The Engineer shall issue Train Run Certificate and the Contractor's 36 months operation and maintenance period shall commence.
2. On successful completion and commissioning of the remaining works including further demolition works, site-works, further construction works, landscaping and planting, the Engineer shall issue a Certificate for the works not included in the pumping station Trail Run Certificate.
3. On the successful completion of the operation and maintenance period, including training of the Employer's staff, the completion of a 72 hour demonstration. The pumping station Final Taking-Over Certificate will be issued.

B. The Contractor shall provide all Operation and Maintenance documentation including the As-Built Drawings covering all the items prior to the issue of the relevant Taking - Over Certificate.

C. The Contractor shall provide all spare parts for all the items prior to the issue of the Taking-Over Certificate.

1.03 Submittals:

A. Prior to the issue of each Inspection Certificate, the following documents shall be submitted for all the Works included in the Inspection Certificate:

1. As-Built Drawings,
2. Operation & Maintenance manuals,
3. Manufacturer's data in separate volumes for mechanical equipment, electrical equipment and instrumentation & control equipment,
4. Inspection and Test reports,
5. Performance Test reports,
6. All originals of permits with fee receipts,
7. Warrantees and guarantees in the name of the Employer,
8. Training manuals,
9. Other documents as required by the Engineer under the contract.

PART 2 - PRODUCT

A. There are no products in this section.

PART 3 - EXECUTION

3.01 General:

A. Prior to each Inspection Certificate being issued, the Works in question shall be subjected to the following actions:

1. Ensure all light fittings are fully functional.
2. Clean all areas to the satisfaction of the Engineer using only cleaning materials recommended by the manufacturer for the surfaces to be cleaned and as recommended by cleaning material manufacturer.
3. Remove waste materials and rubbish from the project site.
4. Vacuum all control and instrumentation panels.
5. Conduct final inspection of exposed interior and exterior surfaces and of concealed spaces in the presence of the Engineer.
6. Remove grease, dust, dirt, stains, labels, fingerprints and other foreign materials from interior and exterior finished surfaces open to view, including glass and other polished surfaces and mechanical accessories and electrical fixtures.
7. Broom clean paved surfaces and rake clean planted areas.
8. Remove debris and surplus materials from roofs, tanks downspouts and gutters etc.
9. Replace used ventilation and air conditioning filters.
10. Repair any cracks observed in buildings.
11. Replace any broken glass panes, tiles, electrical switches, sockets etc.
12. Paint or polish, as appropriate, all buildings to look new to the satisfaction of the Engineer.
13. Repair pathways and roads damaged during construction or the O & M period.
14. All water / sewage line faucets and fittings to be replaced if damaged.
15. Ensure all fire extinguishers are fully functional.

3.02 Removal of Temporary Facilities:

A. The Contractor shall remove all temporary facilities from site. All temporary facilities and all waste material shall be removed prior to the issue of the final Taking-Over Certificate.

3.03 Operation and Maintenance Data:

A. Not later than two weeks prior to the start of the initial 30 day pumping station operation period, the Contractor shall submit to the Engineer one draft copy of the manuals containing complete instructions for operation and maintenance of the equipment and materials supplied. Following the Engineer's approval, submit six copies of the final version of the manuals.

B. Not later than two weeks prior to the commissioning of the remainder of the Works, the Contractor shall submit to the Engineer one draft copy of the manuals containing complete instructions for operation and maintenance of the equipment and materials supplied. Following the Engineer's approval, submit six copies of the final version of the manuals.

C. The manuals shall be bound in expanding barlock binders with dividers and drawing pockets. The front and the spine of each binder shall be embossed with the following information:

1. Employer's name.
2. Project name.
3. Date of completion.

4. Volume number
5. Set number

D. Refer to Section 01007 and Referral forms for additional submittal requirements.

E. Operation and Maintenance Manuals shall be prepared for each pumping station including a complete explanation of operating principles and sequences of each process and/or item of equipment, daily and periodic checks, start-up, normal, shut-down and emergency procedures, trouble-shooting, safety requirements, confined space entry procedures, lubrication schedules and procedures, preventive maintenance etc.

The Operation and maintenance Manuals shall include the details of a routine operational procedure in which the pumps shall be controlled in such a manner as to provide a flushing flow to the downstream system. The details of the procedure (frequency, flushing volume, degree of manual control required) to be agreed with BMC.

F. The Contractor shall organize the manufacturer's data and manuals and other documents in separate volumes in an easily accessible, logical manner. The volumes will include the following information:

1. Manufacturer's data on operation, maintenance, replacement parts lists, lubrication charts and recommended inspection intervals for all equipment including valves, plumbing fixtures, lighting, controls, cranes, switches, heating and ventilating equipment etc. The manufacturer's data shall include a maintenance schedule for the equipment including a list of required activities and the recommended frequency for each activity.
2. Instructions for the care and maintenance of the building components including the care of tiled and other types of floor finishes, wall and other surface finishes.
3. Vibration data on major items of rotating equipment .
4. Contact persons, companies, names, mail and e-mail addresses and telephone and facsimile numbers of sub-contractors and suppliers.
5. Copy of hardware and paint schedules.
6. Guarantee commencement date and duration of guarantees. Copies of all product and equipment guarantees.
7. A complete list of instructions and the names of products to be used for the cleaning and maintenance of finished building surfaces.
8. Instructions for installation, adjustment, operation, lubrication and maintenance of each item of equipment.
9. Complete spare parts list with catalogue numbers and equipment, valve and hardware schedules.
10. Copies of signed inspection and installation reports.
11. Balancing reports, vibration studies, coordination studies, electrical wire resistance test reports etc.
12. A final version of the process control narrative.
13. A final version of the instrument data sheets.
14. CDs of the instrument ladder logic drawings.
15. Certificates and instructions for equipment.
16. As-constructed room finishes schedule.

3.04 Certificates and Instructions for Equipment:

A. Submit the following to the Engineer two weeks prior to the start of any plant operation:

1. Complete inspection reports of tests done and results signed by the manufacturers or accredited agents of the equipment incorporated into the works, stating that their qualified representatives have tested the equipment which they supplied and have found it to be satisfactorily installed in all respects, and in proper working order.
2. An electrical inspection certificate from the Electric Safety Authority from Public Works Department of the State Government having jurisdiction, stating that its representative has inspected the electrical installations in the works and is satisfied that they are in accordance with the code requirements.
3. Provide six copies of the report on rotating equipment vibration analyses carried out, including graphical vibration signatures of all rotating equipment.

B. Before the end of the Defects Notification Period, submit six copies of a second report of rotating equipment vibration, showing that the equipment remains in proper operating condition to the Engineer,.

3.05 Warranty and Maintenance:

A. The Warranty and Guarantee periods shall commence following successful commissioning.

B. The Contractor shall promptly correct any defects during the Defects Notification Period.

C. The Contractor shall be responsible for extended warranties and guarantees as detailed in the various sections of the Specifications.

D. The Contractor shall submit the required guarantee certificates and documentation as specified.

END OF SECTION 01016

SECTION 01020 CIVIL DESIGN REQUIREMENT

PART 1 - GENERAL

1.01 Reference:

A. Section 01000, applies to and governs the work of this Section.

1.02 General:

A. This section sets out the particular requirements for the civil engineering and building works and site services at the IPS Site required by the Contract unless stated otherwise elsewhere in the Contract.

B. Design Requirements

In designing the Works the Contractor shall comply with the following requirements:

- The Works shall utilise a minimum area, within the Site, consistent with safe and reliable operation and maintenance;
- Means of access and egress for personnel above and below ground shall comply with safe and reliable procedures and all Indian regulations;
- ensure the design is consistent with relevant national and local legislation, guidelines and policies;
- all pipelines, ducts, mains and services shall be provided with flexible joints able to accommodate the differential movement that may occur between buildings and the surrounding soil;
- All pipelines, ducts, mains and services shall be provided with surface access chambers (including pipeline puddle flanges, dismantling couplings or adapters and rocker pipes) at bends over 30 degrees and at all connections including valves and meters;
- Buildings shall be designed in accordance with the current edition of the National Building Code of India / relevant latest editions of IS codes/ any other latest standards, codes, IRCs etc.
- All walkways, stairways and platforms shall have 1.2m clear spacing between the handrails.

1.03 Site Works

A. Site works consists of:

- Demolition of existing unused structures (above ground & to a depth of 1m below finished ground level in case of space being not utilised for the construction of new structure or upto foundation level if space is utilised for the construction of new structure).
- Road works, grading, landscaping, etc. as required to prepare for the new works.
- Provision of temporary roads, grading, etc. as required to construct the new works.
- Provision of final grading, new site road works with under base(s) and asphalt topping for external road from IPS to WWTF and Concrete roads for internal plant roads inside IPS suitable for heavy duty truck load condition.
- During excavation works, Contractor shall maintain smooth flow of traffic. Contractor shall take adequate measures especially during trench excavation for pipe line laying works to allow vehicles to move over the excavated portion (trench) by providing temporary arrangements such as installing MS plate (over

the excavated trench by proper support) or any other suitable method in consultation with the Engineer. Contractor shall take adequate measures to prevent collapse of excavated surfaces. No separate payment shall be done to Contractor for the same.

B. All buildings shall be designed to withstand loads from; wind loads, earth pressures, seismic loads, water pressures, surcharges due to temporary or permanent conditions; dead load and imposed load in combination to comply with the relevant design codes and standards.

C. Wind loadings on structures shall be calculated in accordance with IS: 875 (Part 3).

D. The effects of air temperatures and fluctuations in air temperature shall be taken into account in the designs.

E. Earth and water pressures shall be determined by the Contractor and shall take into account the prevailing site conditions and the proposed construction methods.

F. The Contractor's attention is drawn to the fact that the ground water table has been recorded in close proximity to the existing ground levels. Geotechnical investigations may not reflect this fact as they may have been carried out in dry weather. Water retaining structures shall be designed and constructed for uplift based on the external ground water table at ground level and the structure empty. Uplift shall be resisted by dead weight with a factor of safety of 1.2. Ground anchors and pressure relief valves as a means of dealing with uplift are not permissible. Structures shall also be designed to resist full internal water pressure with no external water pressure or earth pressure.

G. Surcharge loads adjacent to basement walls of not less than 10 kN/m^2 shall be allowed for in addition to fill loads. The Contractor shall further design for any surcharges exceeding this figure occasioned by his proposed method of construction or operation.

H. Dead loads shall be assessed by the Contractor using the proposed sizes and material densities.

I. Loads from overhead cranes comprise dead loads from crane bridges, gantry beams and hoists, live loads based on crane safe working loads and an allowance for dynamic effects. These loads shall be factored using the appropriate load factors.

J. Similarly plant dead and live loads shall be assessed including an allowance for pipe thrusts and dynamic effects in the design of base slabs and roof slabs. Plant loading shall not be taken into account in determining the factor of safety against flotation.

K. All loads used in the design, including those of mechanical and electrical plant shall be clearly indicated in the design calculations, which are to be included within the Contractor's Documents.

1.04 Earthworks, Ground Improvements and Foundations

A. The scope of work is mentioned in Part II of the tender document.

B. The Structural audit report provided is only for information purpose and the Contractor shall conduct Structural audit at no additional cost to BMC. The structural audit report shall be submitted to BMC.

C. The Geotechnical investigation is to be carried out upto suitable depth along the route of proposed rising main and inside the IPS so that necessary information

required for design and laying of rising main and appurtenant structures are available.

D. The Contractor is wholly responsible for developing his approach to constructing the foundations for structures and dealing with any related issues such as differential settlement. The Contractor remains fully liable for the selection, design, construction and performance of the ground improvement measures he adopts.

E. The contractor is responsible for dewatering of sewage from pumping station before start of the work.

F. Prior to commencing earthworks and foundation works whether as described above or using different techniques, the Contractor shall submit the geotechnical interpretive report, calculations for earthworks and foundations and a detailed construction method statement and programme relating to the works that are to be carried out.

G. Refurbishment of Sewerage Pumping station structures and new structures that are to be constructed should be cast-in-situ reinforced concrete.

H. All interior faces of walls, exposed roofs of structures of above and below grade and exterior surfaces above finished grade shall have a smooth form finish in accordance with ACI 301 Surface Finish 3.0 (SF-3):

1. Patch voids larger than 1/2-inch-wide or 1/2 inch deep.
2. Remove projections larger than 1/8 inch.
3. Patch tie holes.
4. Provide surface tolerance Class A in accordance with ACI 117.

I. All exterior walls below finished grade and other surfaces shall have an unworked finish free from substantial voids, honeycombing or other large blemishes, unless otherwise specified.

J. The external visible surfaces shall be painted.

K. Influent Pumping station structures are to be water tight without leaks.

L. The cement and chemical materials to be utilized in the concrete make-up are to be suitable for final use with wastewater and its potential aggressive conditions.

M. All wastewater retaining structure wall and slab thicknesses are to be designed to suit the load conditions.

1.05 Administration Facilities

This section sets out the minimum requirements for administration facilities to be provided at the Site by the Contractor.

For the sole use of the Contractor:

i) Office Nr.1 $\geq$ 25m^2 for the Operation Service Period of the Contract

For the sole use of the Employer or Employer's support staff:

i) Office Nr.2 > 25m^2 for the Operation Service Period of the Contract, equipped with PC and the office equipment specified for operational phase of Works;

ii) Double Office Nr.3 >25m^2 for the Operation Service Period of the Contract, equipped with the PCs and office equipment specified for the operational phase of Works.

The Contractor shall be wholly responsible for the operation and maintenance of all of these facilities including those provided for the Employer's sole use and the Shared facilities throughout the Contract period

1.06 Architectural Design

A. Externally the buildings shall be visually aesthetically pleasing demonstrating a high quality and sensitivity to the local setting. However the design shall also be up-to-date and comply with the current international philosophy of design, and maintain clean and simple lines. The Contractor's attention is drawn to the architectural renderings provided in the volume entitled Background Information. The Contractor shall ensure that a similar high standard of architectural and landscaping is provided in his design.

B. The design approach for buildings and structures shall be to achieve a safe, functional and durable facility. Materials and their colours for external surfaces shall be selected for their visual qualities and proven durability to withstand all the local climatic conditions likely to be experienced, ease of maintenance and reasonable cost. The civil engineering and building works design shall provide working conditions and facilities entirely suitable for the Works, that are conducive to its efficient operation and to ensure that maintenance during the life of the Works is minimised.

C. Local materials shall be used when possible with regards to quality and reasonable cost.

D. Effective methods of rainwater disposal shall be provided so that no roof or overhang water is left to run down the face of the building. Effective drip stops shall be incorporated in all overhanging elements.

E. The Contractor shall allow in his design for the climatic conditions and the high humidity in some of the processes involved. In this respect, the Contractor shall endeavour through his design to minimise energy consumption by improving system efficiencies, insulation, draught stripping, humidity control, heat recovery and controls.

1.07 Materials

A. The design and selection of Materials for all buildings shall be guided by the need to ensure that various elements have long, trouble free operational lives and that the requirements for building maintenance are reduced to a minimum.

Steelwork: Internal steelwork shall have a protection system in line with the requirements of ISO 12944. The protection system shall be suitable for a frequently damp and wet interior and shall have a life to first maintenance of 15 years or more.

External metalwork shall be either stainless steel, aluminium or have a protection system with a life to first maintenance of 10 years or more.

All galvanising shall be undertaken after the manufacture of the steelwork.

Windows*:* Where provided windows shall be consistent with ensuring maximum security.

Floors: Floor slabs shall be designed to cater for plant loading, together with basic floor live loading.

Suspended floor slabs shall, in addition to the above, be designed to carry all dead loads, including the ceiling loads, floor finishes etc as applicable.

Ground slabs shall be cast in situ concrete with a minimum thickness as per Table 14.3.

Doors: All external personnel doors shall be heavy duty and security duty.

Roller shutter and roller panel doors shall be manually operated with suitable gear arrangement to reduce man efforts and of aluminium construction with plastic / protective coating.

1.08 Internal Finishes

A. Internally the buildings shall be functional but smart in appearance and based on a colour co-ordinated design to include all Plant and Materials.

B. The Contractor shall ensure that all areas of walls, floors and ceilings are provided with protective finishes suitable for normal operating conditions with a minimum durability of 15 years to first maintenance unless otherwise stated. When selecting Materials the Contractor shall consider the environment in which it is to be used, the substances to which it is to be exposed and the need to protect any equipment installed in the vicinity. The Contractor shall ensure that the Materials selected provide a safe working environment for the operations staff and are in accordance with all relevant health and safety regulations.

C. In all areas where any liquid or sludge spillage may occur the Contractor shall ensure that the floor is screeded and finished to provide drainage into the nearest suitable Site drainage collection system. The Contractor shall also seal the screed to prevent liquids percolating through to the structural concrete beneath. The Contractor shall ensure that the Materials provide a non-slip surface under all conditions.

D. Areas subject to washdown or splashing shall be protected to a suitable height with ceramic tiles or proprietary epoxy coating and be designed to prevent water retention in the building fabric.

E. Detailing shall allow for ease of replacement of panels that might become damaged and hidden structural panels shall be adequately protected.

1.09 General requirements for Areas to be Finished

A. The following are the minimum standards for finishes:

Schedule of Internal Finishes

Location	Walls	Floor	Ceiling	Skirtings /Architraves
Mess / amenity area	Plaster with wipe down finish	Glazed non slip floor tiles	Wipe down paint finish or wipe down suspended ceilings	Ceramic tile skirting
Offices/ reception area /control rooms	Block work with cement mortar plaster, gypsum plaster over plastered surface for smooth finish with wipe down paint finish	Vitrified glazed tiles	Wipe down paint finish or wipe down suspended ceilings	Vitrified glazed tile skirting

Location	Walls	Floor	Ceiling	Skirtings /Architraves
Store rooms/ Switch room/ Workshop building	Block work with cement mortar plaster with wipe down paint finish	Power floated concrete or granolithic screed with anti dusting hardener/ sealant	Wipe down paint finish or wipe down suspended ceilings	None required
General process areas	Fair faced block work, fair worked concrete finish or glazed tiles to one metre above water level in proximity to process units	Steel float finish laid to falls as appropriate with anti-dusting surface hardener/ sealant	Self finished profiled metal lining sheets	Ceramic tiles to one metre above the top of all process units in splash zones
Special process areas, chemical handling areas, sludge handling areas and process areas subject to corrosive attack	Two part epoxy resin with non slip aggregate (3 mm in thickness) up to 300mm height from floor level.	Two part epoxy resin with non slip aggregate (3 mm in thickness)		
Toilets /sinks / showers	Block work with ceramic tiles	Ceramic tiles	Suspended ceiling to incorporate wipe down finish	Ceramic tile skirting
Vehicle access areas		Sealed screed to protect structural integrity of floors, slabs to be protected in the event of oil, petrol or chemical spillages		

B. External Finishes of Buildings

The external finishes of the administration, pumping stations and other buildings shall have as a minimum either:

- aluminium curtain walling; or
- plastered / rendered finish which shall be painted.

1.10 External Works

Roads and footpaths shall be suitable for their intended use and shall have at least the design standards set out in the specifications and the following requirements.

A. Treatment Facility Roads and Hard standing Areas

Geometric design of roads, junctions, turning circles etc. shall be in accordance with the national guidelines. They shall be designed to provide an adequate number of lay-byes, turning areas, parking spaces, etc. to enable sludge tankers, sludge cake lorries, chemical delivery wagons and other vehicles to discharge or pick up without causing obstructions to others. Hardstanding areas for skips shall be of concrete construction. Junction radii shall be a minimum of 10m.

Carriageway widths shall be adequate to accommodate all vehicles required to operate and maintain the Works and shall provide adequate manoeuvrability in accordance with accepted guidelines. Generally this shall be a minimum of 5m width, but shall be 6m width for roads utilised by sludge vehicles, chemical delivery trucks etc. All internal roads shall have adequate turning radii at bends and junctions so as to allow easy vehicular movement of the type and size of vehicles and loads anticipated to use the site.

Road drainage shall be provided. The roads shall be laid to falls and have adequate capacity to be free draining. Roads shall be sealed and paved in order to prevent soil loss.

Off road parking shall be provided for operational staff cars, maintenance vehicles etc. as determined by the Contractor but with a minimum space for at least 6 vehicles at the treatment facility. The Contractor shall also provide parking and turning capability for one coach and for 6 visitor’s cars at the treatment facility.

Footpaths of minimum 1.5m width shall be provided around all buildings, tanks and chambers and to all areas where equipment is provided.

B. Gates and Boundary

The Contractor shall refurbish the existing boundary wall and gates for the damage caused due to laying of rising main.

1.11 Site Drainage

A. Landscape and unpaved areas shall be finished and graded such that there are no undrained low spots or areas liable to ponding.

B. Surface water from the access road and Influent Pumping Station facility area shall be drained to a drainage system and not to the wastewater stream. The Contractor shall ensure that only uncontaminated surface water can drain to the surface water system. Surface water pipe work shall be designed by the Contractor using a rainfall intensity of 100mm/hr with no surcharging of any pipe work. The Contractor shall obtain consent from the Storm Water and Drain Department for the discharge of the storm water.

C. All road and hard standing areas with potential for contamination, wash waters and works drainage, shall be contained and returned upstream of the preliminary treatment works and downstream of the inlet flow measurement.

1.12 Services to the Site

A. General

The Contractor shall be responsible for provision of all services necessary for the Design Build and Operation Service of the Works. For clarity, the Contractor shall be responsible for the connection and continued provision of all necessary services (electricity, water, telecommunications, etc.) to the Site for the Design-Build Period, including commissioning, and for the provision of the Operation Service. The Contractor shall be responsible for the payment of all such service providers for such services for the entire Contract Period. The Contractor shall not assume that any connection can be made from the existing services being provided to the site.

The Contractor shall advise the Employer's Representative in writing of all arrangements made with the public or private utilities and provide copies of all correspondence between themselves. The Contractor shall give the Employer's Representative adequate notice of all meetings with the utility representatives so that the Employer's Representative may attend. The Contractor shall minute all such meetings and provide the Employer's Representative with copies.

Procedures shall be developed to cater for planned maintenance and for emergency failure of services, such that the performance standards are still met even in the event of such outages.

The Contractor shall determine on Site the exact position of all existing services that may affect or be affected by the Works prior to carrying out his design. He shall submit all details gathered to the Employer's Representative.

B. Electricity Supply Cable Ducts

The Contractor shall provide the electricity supply to the Site, which shall follow the route of the main entrance to the Site and shall be underground in suitably sized ducts. Any new supply shall be underground within the Site and shall be in suitably sized ducts. The route of the electricity supply shall be agreed between the supply

authority, planning authority, and Contractor. Where a looped supply or two supplies are proposed they shall be kept separated by a minimum 2,500mm.

The Contractor shall provide a means to connect an emergency source of power sufficient to operate the facility's essential service during a complete power failure of the electricity supplies and shall also facilitate the use of the power generated from bio-gas(optional) to be utilised. The Contractor designs must demonstrate how this is to be achieved. The facility shall be capable of safe shut down of all non-essential services and of safe start-up upon restoration of power. The Contractor shall develop procedures and demonstrate how these would be carried out in a safe manner.

The Contractor shall research the reliability of the power supplies and the plant through which it is supplied to the Works and demonstrate that the emergency power source will work for the duration of a power supply shutdown such that all of the water quality standards are met.

The Contractor will meet all of the supply authority charges relating to the Site from the Commencement Date.

Supply to the Employers staff quarters shall be maintained at all times whether the supply runs through the Contractors work site or common/shared access.

C. Potable Water

Reference is to be made to Part I, General Conditions of Contract, Clause 23.

D. Telephone Supply

Reference is to be made to Part II, Clause GS :11.

E. Spare Ducting

The Contractor shall provide two spare of minimum 150 mm dia ducts along the route of the access road to the Site, with draw pits suitably spaced for the drawing of control cables in the future.

F. Water Supply for Fire-Fighting

The Contractor shall supply suitable firefighting facilities to meet the requirements of the Chief Fire Officer, BMC.

1.13 Reinforced Concrete

Reinforced concrete shall comply with Section 03000-Concrete.

Due to the severity of exposure of the site (sea water, high chlorides, high sulphates), the Contractor shall design suitable concrete mixes for the exposures anticipated. However, the Contractor’s mix designs shall meet. the following minimum concrete specification for all liquid retaining structures, structures in contact with water (including groundwater), superstructures of all buildings and tanks, load bearing members and foundations:

Minimum concrete requirements

Sr. No.	Structures and units	Requirements
1	• Wall of pumping station	• Grade of concrete : M35 as per IS 456

	and screen chamber • Base slab of pumping station & screen chamber • Top slabs • Chambers of all type(underground) • Framing arrangements like beams at pumping station substructure, etc. • Pump & machine foundation, etc • All underground structures • All structures having direct/indirect contact with ground water/sewage	• Cementitious materials : Portland Slag Cement (GGBS shall be between a minimum of 25% and a maximum of 30% of the cement content) as per IS455 and BS 6699 • Minimum cementitious content per m³ : 340 kg • Maximum water cement ratio : 0.45
2	• Pipe encasement • Pipe protection blocks • PCC benching for profile preparation • Other structural components at superstructure above pumping station and support structures (not having any contact with ground water or sewage for both superstructure and support strucutre)	• Grade of concrete : M25 as per IS 456 • Cementitious materials : Portland Slag Cement (with GGBS content of 30%) as per IS455 • Minimum cementitious content per m³ : 280 kg • Maximum water cement ratio : 0.40
3	• Walkway and platforms outside and around the building/ unit	• Grade of concrete : M25 as per IS 456 • Cementitious materials : Portland Pozzolana Cement / Ordinary Portland Cement • Minimum cementitious content per m³ : 280 kg • Maximum water cement ratio : 0.40
4	• Mud mat below foundations, plinth beams, drains, trenches, pits etc • Plinth protection	• Grade of concrete : M15 as per IS 456 • Cementitious materials : Portland Pozzolana Cement / Ordinary Portland Cement • Minimum cementitious content per m³ : 240 kg

	work	• Maximum water cement ratio : 0.60

Super Plasticiser shall be provided where necessary to ensure necessary workability and wet curing is required.

The following are the minimum grades of concrete which may be used for particular non- structural application:

- M – 20: Pavements
- M – 15: Plinth protection work, Mud mat below foundations, plinth beams, drains, trenches, pits etc.

Reinforcing bars shall be of minimum grade Fe 500 CRS conforming to IS 1786.

The design of RCC structures shall be carried out by the ultimate limit state or the working stress method as per the provisions of IS 456. Concrete exposure shall be considered as severe for the purposes of the depth of cover to reinforcement.

Concrete tanks and other liquid retaining structures shall be designed either as un-cracked sections in accordance with the recommendation of IS 3370 or using limit state design for reinforced concrete in accordance with IS 3370 with a design crack width of 0.1mm. The design must also take into account cracking due to shrinkage, the amount, size and spacing of reinforcement must be adequate for strength and serviceability for shrinkage effects.

RCC walls shall include reinforcement on both faces for sections of 200mm or more, even if not required from a structural design consideration.

All concrete in liquid retaining structures shall include cement additives conforming to IS: 9103 to ensure a dense and watertight finished structure.

The following minimum structural thicknesses shall be used:

Table 14.3 – Minimum section thicknesses

Elements	***Minimum Thickness***
Suspended RCC floors / slabs	200 mm
walkways	175 mm
Ground slab-on-grade	200 mm
Water retaining slabs/ walls	250 mm
Cable/ pipe trenches/ underground pits and base slabs	100 mm
All footings and raft foundations	300 mm
Parapets	150 mm
Sunshades	75 mm (at edge)
Pre-cast louvers	50 mm
Pre-cast trench cover slabs / floor slabs	75 mm
Paving	150 mm
Basement walls and base slab	300 mm
From the fire resistance perspective, the minimum thickness of reinforced concrete members will be as per Figure 1 or Table 16A of IS 456 for at least 2 hour of fire resistance.	

Note that these are the general minimum thicknesses employed. Structural elements shall be designed in accordance with the loads to be imposed.

All steel shall be procured from “original producers” who manufacture billets from iron ores and rolled the billets to produce steel confirming to IS 1786. No re-rolled material shall be accepted. If instructed by the Employer’s Representative, the Contractor shall submit the manufacturer’s test certificates for the steel. Random tests on steel supplied by the Contractor may be performed by the Employer as per relevant Indian Standards. Each steel bar shall be identified by the number duly moulded on the bar itself.

1.14 Liners to Concrete Material

A. Due to the potential for H_2S corrosion in the wastewater containing structures, all Waste water retaining structures shall be lined with Polyurea/ Epoxy.

B. The following are the design requirements for all reinforced or plain concrete structures:

C. All blinding and levelling concrete shall be a minimum 100 mm thick in concrete grade M15

D. All physical and chemical properties of this Fe 500 CRS grade steel shall conform to IS: 1786-2008. Welded wire fabric shall conform to IS: 1566. All test results (including physical and chemical properties and salt spray tests) have to be produced for the respective bar diameter for each consignment of steel delivered at site and at a frequency of every 20 Metric Tons.

1.15 Design Philosophy

Following are the details are to be included in the general design philosophy;

- Design philosophy for Liquid Retaining Structures with various boundary conditions as applicable
- Design philosophy for buildings
- Design philosophy for all structures

Design philosophy shall include material properties (grade, strength, unit weight etc.), development lengths, lap/splice lengths, Anchorage lengths under tension and compression, clear cover, water proofing specifications, legend used etc.

Reinforcement detail showing the development length at Column/Footing intersection, Column and Roof beam intersections, Walls and Base slab intersections; Walls and cover slab intersections

Detailing of the reinforcement for columns, beams, beam/column intersection, footing/column intersection, and Slabs as per relevant code provisions/requirements depending upon the assumptions made in the design as applicable.

Reinforcement detail for cut-outs in slabs and walls with maximum size of cut-outs

Reinforcement detail at top of RCC trench walls showing edge/seating angles

Pouring sequence of concrete and standard details for construction joints, expansion joints, contraction joints, etc.

Details of Manholes to be placed in the tank

A. Design Loadings

All buildings and structures shall be designed to resist the worst combination of the following loads/stresses under test and working conditions; these include dead load, live load, wind load, seismic load, stresses due to temperature changes, shrinkage and creep in materials, and dynamic loads:

B. Dead Load

This shall comprise all permanent construction including walls, floors, roofs, partitions, stairways, fixed service equipment and other items of machinery. In estimating the loads of process equipment all fixtures and attached piping shall be included, but excluding contents, shall be considered.

Dead loads shall be in general as per I.S. 875 Part (I). However, the following minimum loads shall be considered in design of structures:

Material densities

(i)	Weight of water	:	10 kN/m^3
(ii)	Weight of soil (irrespective of strata available at site and type of soil used for filling etc). However, for checking stability against uplift, actual weight of soil as determined by field test shall be considered	:	20.00 kN/m^3
(iii)	Weight of concrete	:	24.00 kN/m^3
(iv)	Weight of reinforced concrete	:	25.00 kN/m^3
(v)	Weight of Brickwork(exclusive of plaster)	:	20.00 N/m^2 per mm thickness of brickwork
(vi)	Weight of Solid Concrete Block work (exclusive of plaster)	:	24.00 N/m^2 per mm thickness of block work
(vii)	Weight of plaster to masonry surface	:	18.00 N/m^2 per mm thickness
(viii)	Weight of granolithic terrazzo finish or rendering screed, etc.	:	24.00 N/m^2 per mm thickness
(ix)	Weight of MS chequered plates	:	78.5 N/m^2 per mm thickness of plates

C. Live Load

Live Load (LL) shall include the superimposed loads due to the use/occupancy of the structure/building not including dead, wind or earthquake load. Live loads shall be in general as per I.S. 875 Part (II). However, the following minimum live loads shall be considered in the design of structures:

i) Live load on roofs: 1.50 kN/m^2
ii) Live load on floors supporting Equipment such as pumps, valves, Blowers, Compressors etc.: 10.00 kN/m^2
iii) Live load on all other floors walkways, stairways and platforms: 5.00 kN/m^2 (iv) Live load on Toilet areas: 2.00 kN/m^2
iv) Live load Surcharge for Structures (Retaining walls): 10kN/ m^2.

In the absence of any suitable provisions for live loads in BIS Codes or as given above for any particular type of floor or structure, assumptions made must receive the approval of the Engineer prior to starting the design work. Apart from the specified live loads or any other load due to material stored, any other equipment

load or possible overloading during maintenance or erection/construction shall be considered and shall be partial or full whichever causes the most critical condition.

D. Wind Load

Wind loads shall be as per I.S. 875 Part (III).

E. Earthquake Load

Seismic forces shall be as per I.S. 1893.

F. Dynamic Load

Dynamic loads due to working of plant items such as pumps, blowers, compressors, switch gears, travelling cranes, etc. shall be considered in the design of structures.

G. Vehicular Wheel Load

For any structure or pipeline below the roads, Class A loading of IRC 6 shall be considered.

H. Joints

- Movement joints such as expansion joints, complete contraction joints, partial contraction joints and sliding joints shall be designed to suit the structure. However, contraction joints shall be provided at specified locations spaced not more than 7.5 m in both right angle directions for walls and rafts.
- Expansion joints of suitable gap at suitable intervals not more than 30 m shall be provided in walls, floors and roof slabs of liquid retaining structures.
- Construction joints shall be provided at right angles to the general direction of the member. The locations of construction joints shall be decided on convenience of construction. To avoid segregation of concrete in walls, horizontal construction joints are normally to be provided at every 2 m height. PVC water stops of 150 mm width shall be used for walls and 230 mm width for base slabs.

I. Soil Load

- The lateral loads due to soil shall be considered on the structures as applicable in addition to other loads. Also overburden soil load shall be considered where ever applicable.

J. Liquid Load

- The lateral loads due to liquids shall be considered on the structures as applicable in addition to other loads.

1.16 Detailed Design Calculations & Submission

Complete detailed design calculations of foundations and superstructure together with general arrangement drawings and explanatory sketches shall be submitted by the Contractor to the Engineer. Separate design calculations for foundations or superstructures submitted independent of each other shall be deemed to be incomplete and will not be accepted by the Engineer.

- One (1) Copy of a Compact Disc (CD) containing electronic files relevant to the

structure's modelling, analysis and design calculations (Microsoft Excel, Staad Pro, etc.). Files submitted shall be in editable format.

- Print copy (6 Copies) of the contents as submitted in the Compact Disc.
- Good for Construction Drawings
- One (1) Copy of a Compact Disc (CD) containing AutoCAD files (Civil General Arrangement, Structural Dimensions and Reinforcement Details) pertaining to the structure. Files submitted shall be in editable format.
- Print copy (6 Copies) of the contents as submitted in the Compact Disc. Prints to be submitted on A1 Size Sheet as a minimum or A0 Size Sheet when required by the employer.
- Bar-bending schedule indicating the number, shape and size of the rebars shall be submitted as part of the Reinforcement Details
- Detailed drawing showing the location, number and depth of inserts shall be included for any structural steel inserts/Metal inserts in the structure such as rungs, bolted connections for ladders/railings, etc.
- Location of Construction Joints and pour sequence shall be included on the drawing for base slabs, walls and top slabs.
- Revised drawings shall be submitted by clouding at the location with the latest revision number and also show the history of revisions in a table format just above the title block.
- The design considerations described hereunder establish the minimum basic requirements of plain and reinforced concrete structures, masonry structures and structural steel works. However, any particular structure shall be designed for the satisfactory performance of the functions for which the same is being constructed. The Contractor shall also take care to check the stability of partly completed structures.

1.17 Design Criteria for Underground Liquid Retaining Structures

All underground or partly underground liquid containing structures shall be designed for the following conditions:

- Liquid depth up to full height of wall: no relief due to soil pressure from outside to be considered
- Structure empty (i.e., empty of liquid, any material, etc.): full earth pressure and surcharge pressure wherever applicable, to be considered
- If water table exists, earth pressure to be considered for submerged soil conditions with reference to the geotechnical recommendation
- Partition wall between dry sump and wet sump: to be designed for full liquid depth up to full height of wall
- Partition wall between two compartments: to be designed as one compartment empty and other full

Structures shall be designed for uplift in empty conditions with the water table considered upto finished ground level even though it is not indicated in geotechnical report and minimum factor of 1.25 shall be ensured against uplift or floatation, by considering 0.9 times the characteristic dead load

Walls and bases shall be designed under operating conditions to resist earthquake forces from earth pressure mobilization and dynamic water loads (Hydrodynamic Impulsive Pressure and Hydrodynamic Convective Pressure)

For general retaining walls and large sized tanks where the walls are designed as retaining walls, sliding check shall also be performed along with over turning checks

Overturning: The stability of a structure as a whole against overturning shall be ensured so that the restoring moment shall be not less than the sum of 1.2 times the maximum overturning moment due to the characteristic dead load and 1.4 times the maximum overturning moment due to the characteristic imposed loads. In cases where dead load provides the restoring moment, only 0.9 times the characteristic dead load shall be considered. Restoring moment due to imposed loads shall be ignored.

Sliding: The structure shall have a factor against sliding of not less than 1.4 under the most adverse combination of the applied characteristic forces. In this case only 0.9 times the characteristic dead load shall be taken into account.

As a design consideration to control crack, though general requirements of IS 3370 & (Annexure F) & IS: 456 shall be followed, All liquid retaining structures shall be designed based on the serviceability crack width limit state (i.e. 0.1 mm crack width) and other limit state requirements also to ensure an adequate degree of safety and serviceability.

In case of Large and Deep Underground Tanks such as Wet Wells, the analysis can be carried by Finite Element Method using STAAD.Pro or any other equivalent software predominantly used and accepted in the industry.

1.18 Foundations

The minimum depth of foundations for all structures, equipment, buildings and frame foundations and load bearing walls shall be as per IS 1904 but in any case this shall not be less than 1.5 meter in the original soil.

Maximum safe bearing capacity of soil strata shall be taken as determined by the Contractor through his own independent investigations. Care shall be taken to avoid the foundations of adjacent buildings or structure foundations, either existing or not within the scope of this Contract. Suitable adjustments in depth, location and sizes may have to be made depending on site conditions. No extra claims for such adjustments shall be accepted by the Employer.

Special attention is drawn to danger of uplift being caused by the ground water table. All underground structural slabs shall be designed for uplift forces due to ground water pressure.

EGL (Existing ground level) and FGL (Finished ground level) shall be marked on all drawings showing foundation/sub-structure details and related design documents.

Machine/static equipment foundations shall be separated from adjoining parts of buildings, other foundations and floor/pavement slabs. Joints at floor/pavement slabs shall be suitably sealed.

Foundations and structures for machines subject to vibrations shall be so proportioned that the amplitude and frequency of the foundation/structure are within the permissible limits as per relevant BIS codes (or as required by the machine vendor).

Machine foundations shall be designed and detailed as per IS: 2974. All appendages to such foundations shall be reinforced suitably to ensure integral action.

Foundations for plant structures in Swampy/Waterlogged areas, for lightly & medium loaded structures and relevant Ground Improvements shall be considered in compliance with the relevant Geotechnical Investigation Report recommendations as

applicable. Also to enlist the services of an experienced & specialized agency for all related design aspects considerations, equipment specifications, and implementation methodology, etc., as an advice for the same.

1.19 Design Requirements

Reinforcement bars and structural steel to be procured only from Primary steel producers with Integrated Steel such as TATA/SAIL/RINL/JSW. No Re-rolled material/secondary steel will be accepted or allowed for any structural works.

Only those firms are eligible who are primary steel producer and should have integrated steel plant in single premises.

Certificate issued by ministry of steel of primary steel producer and integrated steel plant having infrastructure in single premises for producing sponge iron, billet and TMT reinforcement bars using iron ore as base material.

The steel manufacturing company should have latest ISO accreditation for Quality Management System.

The minimum amount of reinforcement in each of the two directions at right angles within each surface zone should be provided as per IS 3370 (Part 2) (latest revision). Definition of surface zones is clearly shown in IS 3370 (Part 2). For slabs, minimum of 10 mm dia bars shall be used to avoid any deformation of lesser diameter bars under loads prior to construction.

All buildings shall have a minimum 1 meter wide, 100 mm thick plinth protection paving in M15 grade concrete or stone slabs/tiles. All plinth protection shall be supported on well compacted strata.

All pipes and ducts laid below the structural plinth and road works shall be surrounded with concrete of grade M25 having minimum 150 mm thick concrete or D/4 (D = outer dia. of pipe) thickness whichever is more.

Use of pressure relief valves to reduce uplift pressure due to ground water table shall not be allowed.

Detailing of the reinforcement shall be considered as per latest Indian code of practices and special publications as applicable.

Water tightness testing of water retaining structures shall be done in accordance with IS: 3370, (Part I). The depth of water for testing shall be up to the soffit of the covering slab.

A. Standards

Materials and workmanship shall comply with the relevant Indian Standards (with amendments) current on the date of submission of the tender.

Where the relevant standard provides for the furnishing of a certificate to the Engineer, at his request, stating that the materials supplied comply in all respects with the standard, the Contractor shall obtain the certificate and forward it to the Engineer.

The specifications, standards and codes listed below are considered to be part of this specification.

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

In case of discrepancy between the Specification and the Standards referred to herein, the Specification shall govern.

1.20 Buildings and Structures

All the building and structure works shall generally comply with the following Employer's Requirements unless otherwise specified elsewhere:

All external walls shall be in 200mm thick solid cement concrete blocks of grade C(5.0) and shall be provided as per IS: 2185 (Latest Revision).All internal partition walls shall be in solid cement concrete blocks of grade C(5.0) and shall be provided as per IS: 2185 (Latest Revision). All internal walls shall be 200mm thick except for toilets. Toilet partition walls shall be in 100 mm thick solid concrete block.

Finishes to concrete liquid retaining structures shall be:

F1 - External surfaces, buried

F2 - External surfaces exposed and up to 300 mm below ground level

F2 - Internal surfaces

Finishes to other concrete structures shall be:

F1 - Buried

F1 - Exposed, where plastering is specified

F2 - Exposed

All internal masonry and ceiling surfaces finish shall have 12 mm thick plain faced cement plaster in cement mortar (1:4) with neat cement finish on top. The plastered surface shall made smooth by using cement based putty or gypsum for better architectural finish. Over this, one coat of primer and two coats of plastic emulsion paint of approved quality and shade shall be provided.

All external masonry and concrete with rough board finish shall have 20 mm thick sand faced cement plaster in two coats, base coat 12 mm thick in cement mortar 1:4 and finishing coat 8 mm thick in cement mortar 1:4. Waterproofing compound of approved make and quality shall be added to the cement mortar in proportions as specified by the manufacturer.

All external surfaces exposed and up to 300mm below ground level have one coat of primer and two coats of waterproof cement based paint of approved quality and shade. A coat of silicone water repellent paint shall also be applied thereon.

All staircases shall have 25 mm thick granite stone of approved quality and 150mm high skirting set in cement mortar in 1:4 to give an overall thickness of 50 mm.

Stairways shall be provided to permit access between different levels within buildings. Staircase shall be minimum 1500 mm wide, minimum Tread = 250 mm, maximum Riser = 175 mm and maximum 15 number of steps per flight unless specified otherwise. Staircases in general shall not be steeper than 40°. Staircases having space constraints may be steeper than 400. The maximum vertical run for a single flight of stairs shall be 3.0 M.

All roof tops and overhead tanks shall be made accessible with ladder provision. Vertical step ladders fitted with landing point extensions will be permitted where considered appropriate by the Engineer to access areas not frequently visited.

Steel staircases shall be constructed of standard channel stringers with M.S. grating treads 25mm thick with non skid nosing. Steel Ladders shall be minimum 600mm wide and shall not exceed 6m of straight run. The ladders shall be painted with epoxy paint.

All hand railing shall be provided with Stainless steel SS-304 with pipe diameter 50. The minimum height of hand railing shall be 1.2m and maximum spacing of verticals shall be 1.2 m. Number of horizontal rails shall be 3 (1 top, 1 intermediate and 1 bottom) with a 100 x 6 toe plate at the bottom.

Building plinth shall be minimum 450 mm above average finished ground level around building or high flood level whichever is more.

All concrete channels and ducts used for conveying liquid shall have inside finish of type F2. The width of concrete channels shall not be less than 500 mm. All open channels shall be provided with hand railings (3-rail) or concrete walls to a minimum height of 1.2 m from the access surface elevation. All concrete surfaces of structures conveying raw sewage or primary effluent upstream of the aeration tanks shall be protected from corrosion with a Polyurea / Epoxy lining.

Kerbs to be provided below the hand railing on the catwalks/pathways should be as per relevant sections of Factory Act. It shall not be less than 150mm.

All exposed surfaces of inserts embedded in concrete shall be painted with two coats of enamel paint over one coat of red oxide zinc chrome primer. Surfaces in contact with concrete shall not be painted.

All structural steel members shall be painted with two coats of enamel paint over one shop and one field coat of red oxide zinc chrome primer.

All rooms in the treatment plant buildings shall be provided with appropriate sign boards indicating the function of the rooms involved written in Marathi, Hindi and English Languages.

The design of buildings shall reflect the climatic conditions existing on site. Process buildings shall as far as is possible permit the entry of natural light, and the use of glazed paneling shall be kept to a minimum and preference given to wall openings protected by weather canopies.

Emergency exit doorways shall be provided from all buildings in order to comply with local and international regulations .Stairways and paved areas shall be provided at the exit points.

All concrete structures in contact with sewage and/or sludge shall be provided with full interior corrosion protection linings and/or coatings of appropriate material and thickness to be approved by BMC.

To assess the compressive strength of concrete for existing structures. Carry out Non Destructive Test as per IS-13311.

Carry out rebound hammer tests for determining the estimated compressive strength of concrete and uniformity of concrete in terms of surface hardness test as per relevant IS / ASTM/BS or as directed by site in-charge. Carry out ultrasonic pulse velocity test for ascertaining the quality of concrete, soundness and density of concrete, uniformity of concrete in terms of density, crack depth and width, cause analysis of crack propagation as per relevant IS / ASTM/BS or as directed by site in-charge.

Carry out core compressive strength test by concrete extraction for evaluation of exact in-situ compressive strength, grade and fck value of concrete as per relevant IS / ASTM/BS or as directed by site in-charge.

If any structure during the sampling and testing process gets physically damaged, the same is to be reinstated to its original condition at Contractor's own cost and nothing extra would be paid on account of it.

Regarding arrangement for water and electric supply, the information provided in Part I/II will be applicable.

The work shall be carried out in such a way that existing utilities, cables etc. are not damaged. In case of any unintentional damage by way of working, the agency will restore that to original condition at no extra cost to the Employer.

All work/activity shall be done in consultation/approval of BMC Maintenance team.

During the course of this scope of work, dewatering of trenches if required shall be Contractor's responsibility.

END OF SECTION 01020.

SECTION 01021 - PIPE AND PIPE FITTINGS

2.1 Pipelines

2.1.1 Scope

This Specifications covers supply, fabrication, testing, delivery at site, laying, erecting and jointing of buried pipelines, as well as pipelines above ground and inside the pump house.

The sections below specifically cover fabrication of pipes, specials, testing, painting, transporting to Site as well as laying of buried pipelines.

2.1.2 Applicable Codes & Specifications

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

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

1.	IS	:	2062	-	Steel for general structural purposes (Fusion Welding Quality).
2.	IS	:	2002	-	Steel plates for pressure vessels for intermediate and high temperature service including boilers.
3.	IS	:	814	-	Specifications for covered Electrodes for Metal Arc Welding for Mild Steel.
4.	BS	:	639	-	Covered electrodes for manual metal arc welding of mild steel and medium tensile steel.
5.	AWS	:	A-5.1	-	Specification for mild steel covered arc welding electrodes.
6.	IS	:	3613	-	Acceptance tests for wire flux combinations for submerged arc welding.
7.	AWS	:	A-5.17	-	Specification for bare mild steel electrodes and fluxes for submerged arc welding.
8.	IS	:	1367	-	Technical Supply Conditions for Threaded Fasteners.
9.	IS	:	2016	-	Plain Washers.
10.	IS	:	2074	-	Ready Mixed Paint, Red Oxide Zinc Chrome and Priming.
11.	IS	:	102	-	Ready Mixed Paint, Brushing, Red Lead, nonsetting, Priming.
12.	IS	:	1786	-	Specification for Cold Twisted Steel bars for concrete reinforcement.

13.	IS	:	432 (Part -I)	-	Specification for Mild Steel Medium Tensile bars and hard drawn steel wire for concrete reinforcement : Tensile steel Bars.
14.	IS	:	432 (Part –II)	-	Specification for mild steel Medium Tensile steel bars and hard drawn steel wires for concrete reinforcement : Hard drawn steel wire.
15.	IS	:	269	-	Specification for ordinary and Low heat Portland cement.
16.	IS	:	8041	-	Specification for Rapid hardening Portland Cement.
17.	IS	:	383	-	Specification for coarse and fine aggregate from natural Source for concrete.
18.	IS	:	12330	-	Specification for Sulphate Resisting Portland Cement.
19.	IS	:	456	-	Code for practice for plain and reinforced concrete.
20.	IS	:	800	-	Code of practice for general construction in Steel.
21.	IS	:	816	-	Code of practice for use of Metal Arc Welding for General Construction.
22.	IS	:	4353	-	Recommendation for Submerged Arc Welding of Mild Steel & Low Alloy Steels.
23.	IS	:	817	-	Code of practice for Training and Testing of Metal Arc welders.
24.	IS	:	1182	-	Recommended practice for Radiographic examination of Fusion-Welded Butt Joints in steel plants.
25.	IS	:	2095	-	Code of Practice for Radio-graphic Testing.
26.	IS	:	3658	-	Code of Practice for Liquid Penetrant Flaw Detection.
27.	IS	:	5334	-	Code of practice for Magnetic Particle Flaw Detection of Welding.
28.	ASTM	:	E-94	-	Recommended Practice for Radiographic Testing.
29.	ASTM	:	E-109	-	Dry Powder Magnetic Particle Inspection.
30.	ASTM	:	E-138	-	Wet Magnetic Particle inspection.
31.	ASTM	:	E-165	-	Liquid Penetrant Inspection.
32.	IS	:	3600	-	Code of Procedure for Testing of Fusion Welded Joints and weld-metal in steel.

33.	IS	:	4853	-	Recommended Practice for Radiographic Examination of Fusion Welded Circumferential Joints In Steel Pipes.
34.	IS	:	3589	-	Specification for Electrically welded steel pipes for Water Gas and Sewage (150 to 2000 mm Nominal size).
35.	IS	:	6631	-	Steel pipes for Hydraulic Purposes.
36.	IS	:	7343	-	Code of practice for ultrasonic Testing of Ferrous Welded Pipes and Tubular Products.
37.	IS	:	2548	-	Safety Code for Industrial Radiographic Practice.
38.	IS	:	5822	-	Code of Practice for Laying of Welded steel pipes for water supply.
39.	IS	:	1566	-	Specification for plain hard drawn steel wire fabric for concrete reinforcement.
40.	IS	:	5878 (Part VI)	-	Code of practice for construction of tunnels. Steel lining.
41.	IS	:	808	-	Rolled Steel Beam,Channel and Angle Sections
42	IS	:	9585	-	Metal-Arc welding of carbon and carbon manganese steels- Recommendations.
44	IS	:	3664		Code of practice for ultrasonic pulse echo testing by contact and immersion methods
45	IS	:	11906		Recommendations for Cement-Mortar Lining for Cast-Iron Mild Steel and Ductile-Iron Pipes and Fittings for Transportation of Water
46	AWWA	:	M11: 1998		Steel Pipe – A Guide for Design and Installation
47	IS	:	62:1950		Graphite for Paints
48	IS	:	823: 1964		Code of procedure for manual metal arc welding of mild steel
49	IS	:	2595: 2008		Code of Practice for Industrial Radio-graphic Testing.
50	IS	:	2598: 1966		Safety Code for Industrial Radio-graphic Practice.

51	IS	:	2720: 1983	Method of test for soils
52	IS	:	6419: 1996	Welding Rods and Bare Electrodes for gas shielded arc welding of structural steels
53	IS	:	7280: 1974	Specification for Bare Wire electrodes for submerged arc welding of structural steels.
54	IS	:	7307: 1974	Approval tests for welding procedure
55	IS	:	7310: 1974	Approval Test for welders working to approved welding procedures
56	IS	:	10221	Code of practice for coating and wrapping of underground mild steel pipelines
57	IS	:	10234	Recommendation for General Pipeline Welding
58	IS	:	12089	Specification for granulated slag for the manufacture of Portland slag cement
59	ISO	:	9001: 2008	Quality Management Systems –Requirements
60	ISO	:	14001: 2004	Environmental management systems – Requirements with guidance for use.
61	OHSAS	:	18001	International Occupational Health and safety standard

2.1.3 Materials

a) Steel Plates - The steel plates for pipes, fittings, specials and stiffeners shall be of mild steel conforming to IS: 2062 Grade B. Only SAIL/ Jindal/ Essar / Ispat / TISCO Steel M.S. plates shall be used.

b) Welding consumables - such as electrodes, filler rods and wires shall conform to IS : 814, IS : 3613, IS : 6419 and IS : 7280.

c) Ultrasonic Testing of welded joints: Ultrasonic Testing to carried out as per IS3664 and it should satisfy testing criteria specified in IS 7343.

d) Cement - The cement used shall be of one of the following :

   i) Ordinary Portland Cement conforming to IS: 269

   ii) Ground granulated blast furnace slag cement conforming to IS 12089

   iii) Sulphate Resisting Portland Cement Conforming to IS: 12330

e) Aggregate - The aggregates shall conform to IS : 383.

f) Water - The water used in preparation of concrete mix shall conform to the requirements of mixing water given in IS : 456.

g) Steel for Reinforcement shall conform to IS : 1786.

h) Before fabrication of pipes and specials / fittings is commenced, the copies of the mill sheets and the manufacturer's test certificates for plates and other materials for the fabrication, shall be submitted by the Contractor to the Engineer for his approval.

When requested by the Engineer, the Contractor shall supply, free of charge to the Employer, for testing in approved laboratory, suitable sample of the materials to be used / used in the works. The cost of such tests shall be borne by the Contractor and shall be included in his item rates.

The contractors shall provide sufficient separate stacking yard for the steel materials, fabricated pipes, and specials scrap in their factory as per the requirements. Size of plates will be measured in millimetres.

The Contractor shall procure plates and other structural steel required for fabricating pipes / specials considering the wastage / scrap etc. and rate quoted shall be inclusive of wastage / scrap etc. The Contractor should note that no claim will be considered on account of scrap wastage / scrap etc.

2.1.4 Inspection

All works and material under specification will be rigidly inspected during all phases of manufacture and testing and such inspection shall not relieve the Contractor of his responsibility to furnish materials and perform work in accordance with this specification.

The Contractor shall notify the Engineer, in advance the production of materials and fabrication thereof, in order that the employer may arrange for mill and shop inspection.

The engineer may reject any or all materials or work that do not meet with any of the requirements of this specifications. The Contractor shall rectify or replace such rejected material / performed work at his own cost, to the satisfaction of the Engineer.

The Engineer shall have free access to those parts of all plants or any other premises and sites that are concerned with the furnishing of materials or the performance of work under this specification.

The Contractor shall furnish to the Employer's inspector reasonable facilities and space without charge for inspection, testing and obtaining of any information he desires in respect of the character of material used and the progress and manner of the work.

The Contractor shall supply free of cost required specimen of materials for testing by the owner at any time during the progress of work and shall bear the cost of all such tests or re-tests to the satisfaction of Engineer.

2.1.5 Manufacture Of Liners/ Pipes/ Specials

2.1.501 General

All pipes and specials shall be manufactured out of steel plates which shall be free from any cracks, surface flaws, laminations, excessive pitting or any other defects. The pipes shall be truly cylindrical and straight in axis. The ends shall be accurately cut and prepared for field welding. The external circumference of the pipe pieces which are to be fixed adjacent to flange adapter/dismantling joint with fixed outer diameter shall not deviate from theoretical one by more than 1mm. To obtain the accuracy the pipe shall be rolled several times, if necessary, as pipe pieces should be truly cylindrical. The external longitudinal welding of this pipe shall be ground smooth flush with surface to the satisfaction of the Engineer. No extra cost shall be charged by the Contractor for this grinding work.

Minor repair by welding or otherwise shall be permitted at the discretion of the Engineer, but such repairs shall be done only after obtaining the previous permission of the Engineer. Any

pipe or part thereof, which develops injurious defects during shop welding or other operations, shall be rejected.

2.1.502 Fabrication of Pipe/ Specials

The contractor shall get fabrication work in a duly valid licensed factory of his own or that of a nominated fabrication contractor.

Preferred Fabrication contractors Mukat Pipes /Lalit profiles/any other fabrication contractor fulfilling the following criteria:

The fabrication contractor shall have successfully carried out the fabrication of 900mm diameter or higher size pipes, specials of similar size, the total length of pipeline shall not be less than 500 meters. Such work shall be completed after 01-01-2010. Necessary certificate in support of this performance shall be enclosed in the Packet B. The factory shall be ISO certified. This factory meant for fabrication of pipes, specials etc. shall also be involved with testing etc., machining as well as painting. For completing the work under the present contract within the contract period, the factory shall be equipped with adequate number of following equipment and plant but not restricted to:

i) Plate bending machines for rolling of pipe drums

ii) Automatic welding machines (suitable for circumferential as well as longitudinal welding).

iii) Hydraulic Testing Machines

iv) Travelling gantry or crane of capacity 10 Tonnes or above.

v) Mobile cranes for loading/unloading of plates, pipes etc. 15 tonnes capacity each.

i) Lathe for machining of the flanges rings, plates etc.

ii) Equipment for sand blasting and applying paint by spray gun.

viii) Equipment for cold pressing of plates upto 25 mm thick to the required curvature (domes, plug plates, M.H. cover etc.)

ix) Any other, considered necessary for carrying out the work covered in scope.

The factory shall have adequate area, and shall also have stacking yard for the stacking of plates, structurals, fabricated pipes etc. and the scrap.

The Bidder shall furnish with his bid the Undertaking where he intends to get the fabrication done, such as its location and the equipment, plant and other facilities available in the factory for the manufacture of Pipes, Liners and Specials required under this contract and the fabrication contactor shall be financially sound to undertake the work. Fabrication of pipes, specials, liners at site is not permitted.

2.1.503 Cutting Plates to Size

The plates shall be indented in such length as to have minimum wastage and so as to make the pipe as far as possible with one longitudinal joint.

Before cutting, all the edges of the plates shall be cleaned by brushing/grinding on both the sides.

After the plates are cut, the edges shall be made smooth and even by polishing with an electrical or pneumatic grinder to remove all inequalities. Care shall be taken to see that the cut edges of the plate are perfectly straight. Jigs to be used for this purpose shall depend upon the types of cutting machine used. The plates cut to the required shape shall be checked for correctness before they are rolled into pipe drums. If any corrections are required, the Contractor shall do the same by re-cutting, if necessary. If any plate or flat is found to be warped, to have corrugations, the defects shall be removed by putting the plate

or flat into a roller press, and no extra payment for this rectification work shall be made. The laminated or heavily corroded plate shall not be used in the manufacturing of the pipe.

2.1.504 Rolling of Plates

The plates cut to the exact size shall be put into a rolling machine to form a pipe of the required diameter. The Contractor shall adjust the rolling machine so as to give a, uniform curvature to the pipe throughout its circumference. The curvature obtained shall be checked by the Contractor's foreman during the process of rolling and if proper curvature is not obtained at any place including the ends, the rolling operation shall be repeated at this stage or even after the longitudinal welding of the drum where directed. Heating of plates to obtain the desired curvature shall not be permitted.

2.1.505 Tacking the Drums

The rolled drums shall be kept on an assembly platform for tacking, care being taken to ensure that the tacked drums have their end faces at right angles to the axis of the pipe. While tacking the drum, a gap of 2 mm to 4 mm shall be maintained, where hand welding is permitted. However, where the welding is to be done on automatic welding machine, there is no need of maintaining such gap depending on the penetration through complete thickness of the welding required. To achieve this objective, clamp spiders, tightening rings and or any other approved gadgets shall be used. Each such drum, before being taken to the assembly platform, shall be numbered on the inside with oil paint, stating the plate thickness as well.

2.1.506 Assembly of Drums into Pipes

The tacked drums shall then be transported to an assembly platform where they shall be tack-welded together to form suitable pipe-lengths. Plate shall be bent in the maximum possible width to reduce the number of circumferential joints.

The longitudinal joints shall be staggered at 90°. The drums when tacked together shall have no circumferential gap when the welding is done on automatic welding machine. But when hand welding is adopted as gap of 2 mm to 4 mm shall be maintain, to obtain a good butt welded joint.

The assembly shall be truly cylindrical and without any kinks. The faces shall be at right angles to the axis of the cylinder. A suitable arrangement for testing the correctness of the face shall be provided by the Contractor at the assembly platform. Only single longitudinal weld shall be allowed in the pipe.

2.1.507 Welding

All components of a standard shell, either straight or bent etc. shall be welded, wherever possible by use of automatic arc welding machine by metallic shielded arc process with alternating current. Hand welding shall not be permitted except for sealing runs and such other minor works at the discretion of the Engineer. The strength of the joint shall be at least equal to that of the parent material.

The Contractor shall use electrodes of approved make and size, the size depending on the thickness of plate and the type of joint. It shall also use with standard current and arc voltage required for the machine in use with such modifications as may be found necessary after experimental welding. For this purpose, samples of welded joints shall be prepared and tested in the presence of the Engineer. The values once determined shall be maintained throughout the work and if any modifications are to be made, a written permission of the Engineer shall be obtained. In the case of thin sheets, electric arc welding may not give satisfactory results and gas welding shall be resorted to. Gas welding shall be subject to the same specifications and tests as those for electric welds.

All the shop and field joints shall be welded, all welding shall conform to the requirements of IS 9595 and IS 4353.

All longitudinal and circumferential joints shall be double welded butt joints. Due to non-accessibility of both side welding, field girth joints shall be accomplished using back up plates.

All circumferential welds involving plates of unequal thickness shall be so kept that the inside surfaces of plates match to provide stream lined joints without alteration in the internal diameter. As far as practicable, welding of dissimilar thickness of shells shall be carried out in the shops.

The welding shall be of the best workmanship free from, flaws, burns, etc. and the Contractor shall provide for his own, electrodes and equipment, ovens to keep the electrodes at the desired temperatures and dry. In order to maintain a good standard in welding, welders shall be tested by the Contractor before they are entrusted with the job. Qualification standard for welding procedures, welders and welding operation shall conform to the requirements of IS : 7307 and IS : 7310 (latest). Periodical tests as regards their efficiency shall also be taken at intervals and those found inefficient shall be removed from the job; only those who pass the test, shall be posted on the job. If an incompetent welder has already welded some pipes, all welding done by him previously shall be fully, checked by X-ray in addition to the regular X-ray inspections. The defects if any, shall be set right to the satisfaction of the Engineer. All such check tests and rectification of defects shall be entirely at the cost of the Contractor. No pipes or steel sections shall be erected unless the work of the welder concerned has been proved to be satisfactory. Site welds shall be done by specially selected welders.

A record shall be maintained showing the names of welders and operators who have worked on each individual joints. Hand-welding shall preferably be carried out by a pair of welders so that, by observing proper sequence, distortion can be avoided. A joint entrusted to a particular individual or a pair shall be as far as possible, completed by them in all respects, including sealing run. No helper or other unauthorised person shall be, permitted to do any welding whatsoever. in case of infringements of above, the persons shall be punished as directed by the Engineer.

The welded joint after welding should not become brittle or sensitive to blows and there should be no loss of toughness due to welding or heat treatment. The material after welding and heat treatment is to be tougher than the base metal, and is to retain its original ductility. No allowance will be made for thinning of weld and the weld should in no point be less than the nominal thickness of plate.

Upon receipt of the order and prior to the start of fabrication, the Contractor shall submit to the Engineer for his approval the “welding procedure" he intends to use in the shop work. Similarly, prior to the start of the field welding, procedure for the field welding must be submitted to the Engineer for his approval. Manual welding shall be adopted only when machine welding is not possible.

2.1.508 Fabricating of Specials in Fabrication Shop

Specials, such as tees, Y-Pieces, bends, tapers, dished ends shall necessarily be in steel and shall be manufactured as per standards and tested in the same manner as the pipe. Small branches, single piece bends, etc. may be fabricated at site, care being taken to ensure that the fabricated fittings have the same strength as the pipeline to which they are to be joined.

2.1.509 Pre-heating of Plates

The metal adjacent to weld shall be preheated where thickness of plate exceeds 32 mm but less than 38 mm so as to reduce the cooling rate of welding, to obtain tough deposit of metal and to prevent development of cracks.

2.1.510 Thermal Stress Relieving

All heavy and rigid parts, specials such as shell piece with manholes, when the nominal thickness of the plates is more than 38 mm and when the welded joints connect plates of different thicknesses they shall be thermally stress relieved. Stress relieving shall be done in a suitable furnace. Where this is not possible then stress relieving may be done by induction coil heating method. No stress relieving for joints in steel pipes is required where thickness of plates is 32 mm or less. For thicknesses between 32 mm and 38 mm, the joints shall be pre-heated before welding as stipulated in IS 5878 part-6.

2.1.511 Tolerance

The shell in the completed work shall be substantially round. The difference between maximum and minimum inside diameters at any cross section shall not exceed 1% of the nominal diameter of the cross section under consideration subject to a maximum of 10 mm.

Machined parts shall be within the following limits :

a) For mitred finished surface = + 20 minutes of arc

b) For elbow angles = + 20 minutes of arc

c) For length of elbow pieces = + 6 mm

Straight pipes shall have their faces perpendicular to the axis of the section with a maximum deviation of 2 mm on either side of the plane.

2.1.512 Shop Testing

After fabrication, but before application of protective coatings all pipes shall be subjected to a shop hydraulic test as per IS3589:2001. All Specials on which shop hydraulic test cannot be conducted shall be tested using NDT methods as per IS3589:2001. Standard lengths of pipes shall be directly subjected to test and non-standard pipe and elbows can be tested as standard pipe before being cut to size.

The test pressure shall ensure that the plate material is stressed to 60% of the minimum yield strength and at least 1.5 times the allowable working pressure as specified by the Engineer.

Each pipe shall be filled with water and the pressure slowly and uniformly increased until the required test pressure is reached.

The pipe to be tested shall be given a serial no. which shall be painted on its inside together with details such as pipe No. Shell thickness, diameter, length etc. as directed. The markings shall be done at four locations - two inside the pipe and two outside the pipe. A fifth marking shall be done with hard punch on the pipe surface externally. It shall be entered in the register to be maintained by the Contractor. It shall be entered in the register to be maintained by the Contractor.

Prior to testing, the pipe shall be inspected thoroughly and all the apparent defects in welding such as jumps, porosity etc. shall be repaired by gouging and re-welding.

The hydraulic test shall be carried out under cover at the fabrication shop, in the presence of and to the satisfaction of the Engineer or the inspection agency appointed by the Employer.

For indicating the pressure inside the pipe an accurate pressure gauge of approved make duly tested and calibrated for the accuracy of readings shall be mounted on one of the closures which close the pipe ends.

The pressures shall be applied gradually by approved means and shall be maintained for at least 10 minutes or till the inspection of all welded joints is done during which time the pipe shall be hammered throughout its length with sharp blows, by means of a 1 kg. hand hammer.

The pipe shall withstand the test without showing any sign of weakness, leakage, oozing or sweating. If any leak or sweating is observed in the welded joints, the same shall be repaired by gouging and re-welding after dewatering the pipe. The repaired pipe shall be retested to conform to the specified pressure.

If any leak or sweating is observed in pipe shell the pipe under test shall be rejected temporarily. The Contractor shall stack such rejected pipes separately in his yard. The Engineer, shall inspect the same and after taking cuts if necessary, shall determine the nature of repairs to be carried out thereon and shall then decide as to how and where they shall be used. No payment shall be made for handling or carrying out repairs, but, payment for the fabrication and hydraulic testing of the pipe shall be released only after acceptance of the pipe with necessary repairs and subsequent testing etc. are carried out by the Contractor to the satisfaction of the Engineer. The Engineer shall be supplied with two copies of the results of all the tests carried out. Pipes will not be allowed to be dispatched to laying site without hydro-testing. Any failure to comply with this may cause the contractors payment to be withheld.

2.1.513 Submission of Daily Progress Report

The Contractor shall submit to the Engineer a daily progress report in the proforma approved by the Engineer, wherein all the details of the work carried out in the factory shall be fully recorded. Similarly, works done in the various units in the factory shall be separately mentioned. The Contractor shall maintain a register of all the finished materials giving dates of carrying out important operations such as testing, transport, etc. The register shall be presented at least once a week to the Engineer, who shall initial the entries after verification.

2.1.6 Transportation Of Pipes, Specials Etc.

All pipes and specials fabricated in the factory and temporarily stacked in the Contractor's yard shall be transported to the site of laying after cleaning them internally etc. The item of transport covers the cost of loading in the factory, transporting to the factory, transporting to the site of laying or to stacking yard selected by the Engineer in its vicinity and unloading and stacking them carefully in such a manner that the material so kept is not easily disturbed or rolled away from the place of stacking. The loading in the factory shall be carried out by means of either a crane, gantry or shear legs, so as not to cause any damage to the finished material. Similarly, while unloading and stacking, great care shall be taken to ensure that the material is not damaged or dented. The contrivances to be used for unloading will be different in different situations and in each case the one approved by the Engineer shall be adopted. The material stacked at site shall be jointly inspected by the Engineer and the contractor and defect or damage noticed shall be repaired to the satisfaction of the Engineer before payment is made.

Props of approved designs shall be fixed to the pipes during transit to avoid undue sagging and consequent distortion. After the pipes are carefully stacked, props may be removed and re-used for subsequent operations. The stacking ground, both in the Contractor's yard and at the site of laying shall be selected in such a way as not to get waterlogged during monsoon. if this cannot be done, the pipes shall be supported on sleepers to avoid contact with wet earth and subsequent rusting. In order to prevent sagging during transit, savings of steel plates can be utilised by cutting to the required length and tacking the same to the pipe ends, in place of props, if approved by the Engineer.

As explained in earlier paragraphs, materials such as pipes, tapers, etc. may be transported to the site of laying as soon as the material is finished in all respects with the permission of

the Engineer to avoid congestion in the Contractor's yard. However, materials such as 'T' branches and other complicated items, shall be stacked in the Contractor's yard until they are required for laying in the field. In view of this, the work of fabrication of such materials shall be properly synchronized as far as possible with the laying operations.

Pipe handling equipment shall be maintained in good condition and any equipment which in the opinion of the Engineer may cause damage to the pipes shall be discarded. Under no circumstances shall pipes be dropped, be allowed to strike one another, be rolled freely or dragged along the ground. No defective/damaged pipe shall be used in the works without rectification to the satisfaction of the Engineer.

No separate payment shall be made for transport of pipes and specials and cost of transport shall be included in the relevant items of Bill of Quantities for fabrication work.

2.1.7 Procedure For Receiving Steel Pipes, Specials Etc.

2.1.701 General

To ensure that the work of erecting pipes is not held up at any stage and place, the Contractor shall maintain an adequate stock of standard specials, flange rings, plug plates, manhole covers, etc. and short length of smaller diameter pipelines, etc. at site in his field stores, in consultation with the Engineer. Wherever possible, the Contractor shall arrange one full month's requirement of pipes, specials, etc. stacked along the alignment.

2.1.702 Stacking of pipes etc. and inspection

The Contractor shall keep in each section a responsible representative to take delivery of the pipes, specials and appurtenances, etc. transported from the fabricating stockyard or received from any other work site to the site of laying and to stack along the route on timber skids. Padding shall be provided between coated pipes and timber skids to avoid damage to the coating. Suitable gaps in the pipes stacked shall be left at intervals to permit access from one side to the other. The pipes, Specials, appurtenances so received on site shall be jointly inspected and defects recorded, if any, such as protrusions, grooves, dents, notches, damage to the internal coating etc. shall be pointed out immediately to the Engineer at the site and in the acknowledgement challans. Such defects shall be rectified or repaired to the satisfaction of the Engineer entirely at the Contractor's risk and cost.

2.1.703 Handling of pipes, specials

It is essential to avoid damage to the pipes, fittings and specials, etc. or their coatings at all stages during handling. The pipes and specials shall be handled in such a manner as not to distort their circularity or cause any damage to their surface treatment. Pipes shall not be thrown down from the trucks nor shall they be dragged or rolled along hard surfaces. Slings of canvas or equally non-abrasive materials of suitable width of special attachment shaped to fit the pipe ends shall be used to lift and lower coated pipes to prevent damage to the coating.

Great care shall be taken in handling the pipe right from the first operation of manufacture until they are laid and jointed. The Contractor will provide temporary props in order to prevent any sagging of the pipes while they are stacked in their yard and while transporting to the site of delivery, i.e. laying. The props shall be retained until the pipes are laid. If at any time these props are found to be dislodged or disturbed, the Contractor shall immediately reinstate them in such a way that the true shape of the pipe shell or specials is maintained to the satisfaction of the Engineer. No defective or damaged pipe or special shall be allowed to be used in the work without rectification to the satisfaction of the Engineer. Any damage to the coating shall be repaired by the Contractor at his own cost to the satisfaction of the Engineer. No separate payment shall be made for use of props.

2.1.704 Dents

Whenever any dent, i.e. a significant alteration of the curvature of the pipe shell is noticed, the depth of the dent shall be measured between the lowest point of the dent and the pipe shell curvature line. All dents exceeding 1 percent of the outer diameter of the pipe shall be removed by cutting out a cylindrical portion of the pipe and replacing the same by an undamaged piece of the pipe. The Engineer may permit insert patching if the diameter of the patch is less than 25 percent of the nominal diameter of the pipe. Repairs by hammering with or without heating shall not be permitted. Any damage to the coating shall also be carefully examined and rectified.

2.1.705 Marking

The component parts of the pipes shall be carefully marked for identification in the field. The marking shall be on the side which will be the inside of the pipe after bending.

The marking operation shall be conducted with full size rulers and templates. Only blunt nose punches should be used.

The plates used for fabrication of pipes shall be laid out in such a way that when the shells are completed one set of original identification markings for the material will be plainly visible. In case these markings are unavoidably cut out, they shall be accurately transferred by the Contractor to a location where these markings will be visible on the completed work.

After the hydraulic tests on the specials and other items, the number of the shell in the line as it will be erected and the direction of flow shall be stamped in a prominent manner on each piece.

A register shall be maintained in suitable proforma giving the following information for each shell tested:

a) Serial No. b) Shell No.

c) Date of test d) Thickness and specification of steel

e) Weight of shell f) Maximum test pressure tested

g) Details of test h) Details of radiographic performance examination of welds

i) Name of Engineers representative witnessing tests

A copy of these details shall be furnished to the owner free of cost.

No separate payment will be made for these markings and the rates for the items concerned shall be deemed to include the cost of such markings.

2.1.706 Extra Cutting and Welding

In course of work, the Contractor may be called upon to either cut steel Plates, pipes and specials etc. or carry out certain welding jobs which are not covered by other fabrication items of the Bill of Quantities. Such special jobs shall be paid for separately, under relevant items.

After cutting the edges shall be made smooth and even by the use of electrical or pneumatic grinders so as to remove all inequalities. Care shall be taken to see that the shape of the materials cut, is not deformed in any way at the time of cutting.

Welding may be done either by electric arc welding or by gas welding and payment shall be per meter of pipe length welded. The Engineer shall specify the leg length in case of lap joints required for each job as well as the gauge of the electrodes to be used. The rate for welding shall also include the cost of assembling, the steel pieces to be welded and holding them in correct position (without distortion) during the process of welding. Cleaning of pipes shall be as given earlier.

2.1.707 Gas Cutting

In the course of the work, the Contractor may be called upon to cut steel pipes, specials, etc. on site. Gas cutting shall be adopted for preparing on site, distance pieces, straps, etc. cutting out holes in the pipeline laid for manholes, scour valves, air valves and other appurtenances, holes required for blast cleaning operation, cutting of pipe faces to form kinks or bends, holes required for bye-pass arrangement.

The rate for gas cutting shall include chamfering for forming 'V' or square cut, cost of aligning, holding member in position, etc., and shall cover thickness upto 25 mm.

After cutting, the edges shall be made smooth and even, by using electrical or pneumatic grinder so as to remove all inequalities. Care shall be taken to see that the item is not deformed in any way at the time of cutting. The ends of the pipe shall have bevel edges or 'V' edges to facilitate hand welding. As field welding is to be carried out from inside in the case of pipes of diameter 1200 mm and above, the bevel shall be from inside. For pipes of smaller diameter, as field welding has to be done from outside only, the edges of pipes shall have bevels to suit the above.

2.1.801 Ultrasonic testing of welding:

All field welded girth joints on steel pipeline/liner inside shafts and tunnel shall be 100% Ultrasonic tested as per requirements of IS 5878 Part VI.

Ultrasonic Testing to be carried out as per IS 3664 and it should satisfy testing criteria specified in IS 7343.

2.1.9 Not Used

2.1.10 Cleaning And External Painting of Pipes And Specials

2.1.1001 General

The fabricated pipes and specials shall be painted externally with Primer, one coat of red oxide of iron paint and covering coat of Grey graphite where they will be exposed after erection. But those pipe surfaces which are to be embedded in concrete shall be provided with cement wash in the shop on their exterior surface.

2.1.1002 Material

Zinc rich epoxy primer and Heavy Duty bitumen paint (Inertol 49W or equivalent) conforming to the following specification shall be used for painting. Each lot of the paint supplied shall be accompanied by the certified copies of the results of the tests carried out by the manufacturer.

If any sample of the Paint and/or primer is not conforming to the specification, the entire consignment to which the sample way pertain shall be rejected. Only those primers and painting materials that have been approved by the Engineer / Owner in writing shall be used for this work.

2.1.1003 Primer

The primer shall be of Zinc Rich Epoxy type conforming to the specifications given below:

a) Specification for Zinc Rich Epoxy Primer

1)	Description	Two pack Zinc Rich consisting of -
i)	Base	Fine Zinc Dust Ground in Epoxy Resin Solution, supplied in paste form.

ii)	Catalyst	Abduct Type - The non-volatile portion of the material (mixed) should consist of 92% Zinc Dust and 8-10% Resin and curing agent.
2)	Shade	Grey
3)	Characteristics	The paint shall provide a complete rust inhibitive barrier coating of high mechanical and abrasion resistance. The film shall be compatible for fusion and spot weld.
4)	Pot Life	4 – 6 Hours
5)	Covering capacity	8-10 sq.m/litre per coat giving a film thickness of one mil.
6)	Mixing Ratio	The proportion of mixing base and hardener should be as specified by the Manufacturer by weight and volume. The mixed primer shall conform to the specifications detailed under Clause 2.1.1003 (e) (1) to (9).
7)	Viscosity of ready Mixed Paint	15-22 in Fort Cup No.4 at: 30° C
8)	Drying Time	Dust Free – 10- 15 minutes Chamber curing – 24-48 hours.
9)	Procedure	Blaser steel surface of the pipes shall be cleaned of dust and grit and shall be primed immediately following cleaning. The surface shall be dry at the time the primer is applied during rain or fog unless protected from weather by suitable housing and subject to the permission of the Engineer. The primer shall be applied by hand spraying and shall be in accordance with the instructions for application as supplied by the manufacturers. The Priming coat shall be uniform and free from floods, runs, sags, drips or bare spots, Any bare spots shall be recoated with an additional application of the primer. All runs, sag, floods or drips shall be removed or all such defects shall be remedied by reblasting and repriming at the discretion of the Engineer and at the cost of the Contractor.

b) Application of Zinc Rich Primer

The primer shall be Prepared as follows:

The primer shall be prepared in the manner and proportion as specified by the manufacturers as mentioned under Clause 2.1.1003(a). However, the mix primer shall conform to the specification as mentioned in Clause 2.1.1003 (a) (1) to (9). The mix of Zinc Rich Epoxy primer shall be prepared 15 minutes before applying on the Works site.

one coat of Zinc Rich Epoxy primer shall be applied by spray right up to the edge of the pipe giving a film thickness of approximately 1 mil.

No thinner should be added to the ready mix paint without the previous written approval of the Engineer. Though the priming coats become dust free dry in 10-15 minutes, the finishing coats shall on be applied after allowing the film to cure at least for 48 hours.

Shade after application : Grey.

2.1.1004 Specifications for Red Oxide of Iron Paint

1. Composition

(a)	Mixed Pigment Dry	-	55% + 2%
(b)	Volatile	-	Not more than 5 %
(c)	Drier	-	These may be added when necessary in order that the paint may conform requirements. Such drier shall not contain volatile matter other than turpentine or white spirit, The drier shall be linoleat or napthenate. Tesinate drier shall not be used.
(d)	Linseed oil	-	The remainder.

2. Pigment : The red oxide of iron shall contain not less than 70% of Ferric Oxide (Fe_2O_3) and shall be free from acid, water soluble salts and all other impurities.
3. Linseed Oil : The linseed oil shall be of genuine quality prepared from linseed, free from turbidity in water. It shall be of such quality so as to become dry within 8 hours and form a film free from being sticky.
4. Thinners : The thinners used shall either be turpentine or white spirit of standard quality as approved by the Engineer.
5. Weight : The minimum. weight in kg/10 litres of paint shall be 15.5 kg within ±3%.

2.1.1005 Specification for Covering Coat (Graphite paint)

1. Composition

(a)	Mixed Pigment Dry	-	Not less than 45%
(b)	Volatile	-	Not less than 10%
(c)	Drier	-	These shall be linoleat or napthonate and shall not contain any volatile matter other than turpentine or white sprit. Resinate drier shall not be used.
(d)	Linseed oil	-	The remainder.

2. Pigment : The pigment shall contain not less than 50% of white lead and 40% of graphite as per IS: 62:1950, the balance being barytes (Pure graphite being 24% min.)

3. Linseed Oil : The linseed oil shall be of genuine quality prepared from linseed, free from turbidity, sediments undissolved in water. It shall have a specific gravity between 0.981 and 0.942 at 30°C. It shall be of such quality so as to become dry within 8 hours and form a film free from being sticky.

4. Thinners : The thinners used shall either be turpentine or white spirit of standard quality as approved by the Engineer.

5. Weight : The weight of one litre of paint shall not be less than 1.5 kg and not more than 2.1 kg.

6. Colour : According to Indian Standard Specifications Shade No. 671.

7. Remaining Clauses shall be as per the General specifications as stated above.

2.1.1006 Inspection and Testing of Zinc Rich Epoxy primer / Red Oxide of Iron Paint and Grey Graphite

(a) Primer

i) Each lot of primer and heavy duty paint supplied shall be accompanied by certified copies of the results of the tests carried out by manufacturers.

ii) The entire procedure of applying the paint as specified shall be rigidly inspected right from blast cleaning stage to the application of the final coat. If, at any time, it is found that the procedure of applying the paint is not as per the standard laid down, all such painting work shall be rejected.

iii) Samples of the paint brought by the Contractor shall be sent to the Testing Laboratory, as directed by the Engineer, for testing as specified. If any sample as found to be not conforming to the specifications, the entire consignment to which the sample may pertain shall be rejected. Samples shall be taken at intervals at the option of the Engineer. All the cost incidental to such testing, such as the cost of the paint, cost of prescribed testing charges and cost of the transport, etc., shall be deemed to be included in the rates quoted by the Contractor for painting.

(b) Red Oxide of iron Paint, Grey Graphite

One sample from each consignment of paint consisting of 50 drums or less shall be taken by the Engineer and got tested in an approved Laboratory. If the test is satisfactory, the consignment shall be passed for use. If it fails, two more samples from two other separate drums shall be taken for test and the consignment shall be accepted for use provided both samples are found satisfactory. In case one or both of the later two samples fail in the test, the whole consignment of the paint shall be rejected and all the rejected tins of paint shall be marked "Rejected" on the lids with paint. The Contractor shall remove the entire consignment of the rejected paint from his works within three days of such intimation from the Engineer. If the rejected consignment is not so removed within the specified time, the Engineer may remove the same to any Municipal Stores in Greater Mumbai at the Contractor's risk and cost, and the Corporation shall not be held responsible for its safe custody thereafter. The entire cost in connection with testing of all the samples of paints, whether satisfactory or otherwise shall be deemed to be included in the rates quoted by the Contractor.

2.1.1007 Painting

a) General

Except with the permission of the engineer, nothing but ready mixed paints of an approved make and brand shall he used. Thinning or heating of paints will not he

permitted except with specific approval and in accordance with instructions. Any warming of paint shall be performed by means of a hot water bath and paint shall not be heated to temperature higher than 40° C All paint shall be in thoroughly mixed condition at the time of application. On completion of the work, the contractor shall remove any oil stains or paint spots, leaving the structures and equipment in a clean and acceptable condition.

Paint shall be applied only to dry, freshly cleaned surfaces, free from dust, rust, scale, grease or other substances which might affect the adhesion or the durability of the coating. In no case shall paint be applied to surfaces that are not to be applied during rainy or misty weather, unless unavoidable, in which case the work shall have suitable and satisfactory protection and such protection shall be maintain until the paint has dried.

All paint shall be applied by skilled workmen in workmanship manner and the average coverage shall be equal to that recommended for first class work with the type of paint and on the kind of surface being painted

b) Preparation of Surface for Painting

i) General

All oil and grease shall be removed from surface to be painted by washing with a suitable solvent and by wiping with rags until completely clean. After removal of all oil and greases, surfaces of metal work required to be painted shall be cleaned by removing all rust, loose scale and dirt by sandblasting, grit blasting or other effective means. Surface which will be permanently or intermittently submerged or subjected to moisture from spray or excessive condensation shall be cleaned to clean metals by sand or grid blasting. After cleaning, all surfaces shall be maintained free from oil, greases, rust, dirt and other contaminations until they have received the final coat of paint.

Surface of stainless steel and bronze and machined surfaces which are attached or adjacent to metal work that is being cleaned or painted shall be protected by adhesive tape or other suitable means during the cleaning and painting operations.

ii) Sand Blasting

The surface of the steel pipes and specials painted shall be thoroughly cleaned by sand or shot blast cleaning process to SA 2.5 finish, to remove all rust mill scale etc. Oil and grease shall be removed by applying a suitable cleaning solution and wiping with clean rags. All foreign matter which can not be removed by blasting process shall be removed as directed by the Engineer/Owner.

Blasting should be done at a pressure of 5.62 kg/sq.cm. (80 p.s.i.) at the compressor end and at 4.93 kg/sq. cm. (70 p.s.i.) at nozzle end. This pressure should be maintained during the entire blasting operations. Improper jointing of hose pipes and resultant reduction in pressure at nozzle end shall be checked and avoided.

The blast cleaned surface shall be primed immediately after blasting is over. The sequence and the programme of blast cleaning application of Zinc Rich Epoxy primer shall be arranged in such a way that the blast cleaned surface shall not remain uncovered with Zinc Rich Epoxy primer for more than 2 hours.

Any deviation from above shall require approval of the Engineer / Employer.

iii) Manual Cleaning

Wherever manual cleaning is approved by the Engineer the surface of pipes and specials shall be thoroughly cleaned by using scrapers and wire brushes to remove all

rust, mill scale etc. to give a shining metallic (SA 2.5) surface. The surface so cleaned shall be washed with water and allowed to dry. A metal cleaning solution of approved make shall then be applied over it. After it is dry, the surface shall be again washed with water, crapping wire brushes simultaneously. A copious use of water is necessary at this state to ensure that the metal cleaning solution is completely removed. The primer coat shall be applied immediately after the surface has become dry.

c) Application of Primer

No primer shall be applied without Prior approval of the Engineer / Owner. During rain or fog, shells of the pipes and specials shall be protected from weather by suitable housing.

The proportion of mixing of base and hardener shall be as specified by the manufacturer by weight and volume. The mix of Zinc Rich Epoxy primer shall be prepared at the work site / yard not earlier than 15 minutes before applying the same on pipe and specials surfaces.

One coat of primer shall be applied by spray giving a film thickness of approximately one mil.

No thinner shall be added to the ready mix paint without previous approval of the Engineer/Owner, and the finishing coats on top of the primer coat, shall only be applied after allowing the film to cure for at least 48 hours.

The priming coat shall be uniform in thickness and free from floods, runs, rags, drips, or bare spots. Any bare spots shall be recoated with an additional application of the primer. All runs, sags, floods or drips shall be removed or all such defects shall be remedied by repriming as per the instruction of the Engineer/Owner.

d) Field Painting

The Contractor shall take proper care during loading/ unloading and transport of the pipes and specials from the shop to the site of erection to preserve the shop paint in the best practicable condition.

After erection of the pipeline on installation all rust spots, damaged areas and site welded portion of the pipeline shall be cleaned to metal and shall be painted with one coat of red oxide of iron paint and covering coat of Grey graphite.

After lapse of 48 hours of application of repairing coats specified above a finish coat of heavy duty bitumen paint shall be applied to exterior surface of the entire pipeline' care being taken to clean the surface with duster prior to application of the said finish coat.

2.1.1008 Inspection

The entire procedure of applying the paint as specified will be rigidly inspected right form the cleaning stage to the application of final coat by the Engineer/Owner. If, at any time, it is found that the procedure of applying the paint is not as per the standards laid down, all such painting work done shall be rejected and shall be rectified by the Contractor at his own cost, as directly by the Engineer /Employer.

2.1.1009 Application of Cement Wash

Where the pipeline is to be cement mortar lined, it shall be given a coating of cement wash internally. Also where the pipeline is to be encased in concrete anchor blocks or encasement, it shall be given a coating of cement wash externally.

The pipe shall be first be cleaned manually as specified in Clause 2.1.1007 (b) to the Engineer's satisfaction. Immediately after a short stretch of the pipe is blast cleaned, the Contractor shall commence coating of the pipe with cement wash.

Before painting is started, the inner surface of the pipe shall be thoroughly scrapped by using scrapers, wire brushes to get rid of rust, mill scale etc. and washed with water. A suitable metal cleaning solution of approved make shall be applied over it. After it has dried, the surface shall again be washed with water and scrapped with brushes simultaneously and allowed to dry.

No Separate payment shall be made for items covered under this clause.

2.1.1010 Internal Cleaning and Painting of Pipeline

2.1.1010.1 Internal Cleaning of Pipeline

Wherever directed by the Engineer, internal surfaces of pipes, specials etc. of all size shall be thoroughly cleaned by repeated hosing of water and simultaneous rubbing with gunny cloth.

Further, when a section of pipeline has been laid and all the work inside it has been completed to the satisfaction of the Engineer, its internal shall be cleaned of all dirt, debris, dust or other deposits.

Pipelines larger than 900 mm diameter shall be cleaned by repeated hosing of copious quantities of water on the pipe surface and simultaneously rubbing the surface with gunny cloth. Cleaning with metal cleaning solution, acid, wire brushed, scrappers or sand paper will not be permitted.

For 900 mm and smaller diameters cleaning of laid pipelines will be restricted to cleansing and scraping out of debris and dirt only.

Cleaning shall be done to the satisfaction of the Engineer. The section of the pipeline once cleaned shall not be entered into for any purpose later. Sufficient precaution shall be taken to prevent the ingress of any dirt, debris, or dust inside the section. Failing this the section shall be cleaned again at the discretion of the Engineer.

In the case of above ground pipeline, the length of the section to be taken up for cleaning shall be decided in consultation with the Engineer from the point of view of ventilation etc.

In case of buried pipeline a section shall be taken up for cleaning after the work of back filling around and over the pipeline is completed and the spiders have been removed from inside.

During the pipe laying operation in the adjoining section, the Contractor shall take all precautions to prevent ingress of water, muck, debris, dirt, dust etc. in the cleaned section, failing which the section shall be cleaned again at the discretion of the Engineer. Where deemed necessary by the Engineer suitable closures shall be provided at the open end or the ends of the cleaned sections. No separate payment shall be made for this item. The item rates quoted for the laying of pipes, painting, etc shall include cost thereof.

At the end of a season's work, closure shall invariably be provided at all the open ends to protect the Pipeline from ingress of sub-soil water, mud, muck, etc.

No separate payment will be made for the work of cleaning and providing closures. The rates quoted for the laying the pipes, painting etc. shall include the cost thereof.

2.1.1010.2 Internal Painting of Pipes And Specials

The internal surfaces of pipelines and liner shall be coated with 1 coat of a two component solvent- free food grade epoxy coating achieving a minimum dry film thickness of 500 microns. The product shall have certification for use in potable water service as per BS 6920 or ANSI Standard 61. The protective coating must be spray applied to the pipe / liner surface using suitable air spray equipment so as to form a completely impermeable, pinhole free and seamless lining.

Cleaning: The painting can be carried out after fabrication in a yard where blast cleaning will be permitted. The pipe surface shall be blast cleaned to Sa 2.5 standards. If oxidation has occurred between blasting and application, the surface shall be reblasted to the specified standard.

Shop Painting: All application shall be as per manufacturer's specification. The contractor shall take proper care during loading/ unloading and transport of the pipes/liners and specials from shop to the site of erection to preserve the shop paint in the best possible condition.

Field painting: after erection all damaged spots and welded portion of the pipeline shall be cleaned to metal and shall be hand painted.

Quality control: Each lot of paint supplied shall be accompanied by certified copies of results of tests carried out by the manufacturers. Samples of paint brought by the contractor shall also be sent to testing laboratory as directed by Engineer for testing as specified by paint supplier.

2.1.1011 Testing of Pipeline

After the work of laying of pipeline is completed and before putting it into commission, the pipeline shall be tested in the field, if so directed by the Engineer, both for its strength and leakage. The procedure for the test shall be as follows:

For the purpose of Pressure testing, the pipeline shall be divided into sections as defined by the Engineer.

Before pressure testing is started, the Contractor shall recheck pipes and valves for cleanliness and shall ensure the operation of all valves. The "open" ends of the pipeline (or sections thereof) shall normally be stopped off by blank flanges or cap ends additionally secured where necessary by temporary struts and wedges. All anchor and thrust blocks shall have been completed and all pipes straps and other devices intended to prevent the movement of pipes shall have been securely fastened. The Contractor shall clean out the whole pipeline and flush it with water, so as to remove dirt, dust and any foreign matter lying in the pipeline. No separate payment for the work of cleaning will be made and the rates under the various items of work shall be included the cost thereof.

Each valve section of the pipeline be subjected to a hydraulic test in full length or in part as may be necessary. For this test, the pipe shall be slowly filled with clean water by opening cross connections with existing mains or otherwise as directed and all air shall be expelled form the pipeline through hydrants, air valves and blow off fixed on the pipeline. Once the pipe is full, the cross connections shall be closed. The pressure in the line should then be raised and maintained by means of suitable approved pumps, to the specified test pressure based on the elevation of the lowest point on the line or section under test. The test pressure shall be not less than the static head pressure or 1.5 times the working pressure whichever is higher for allowable time as per relevant standards.

No section shall be tested unless anchor blocks have been provided at either end, all appurtenances, etc. have been fixed in position, arrangements for cross connections have been made with existing mains. Before starting the pressure test, the expansion joints shall be tightened. The test Pressure shall be maintained for at least 24 hours. The drop in pressure shall not exceed 0.7 kg/sq. cm (10 lbs. per sq. inch) within a period of 2 hours after the full test pressure is built up. Under the pressure, no leak or sweating shall be visible at the welded joints.

During the test, the pipe shall be struck sharp blows with a 4 lb. Hammer. Water shall not spout, ooze, or sweat through any part. In case of leakage anywhere in the factory joints,

whether welded or bolted., the same shall be prepared entirely contractor's cost, which shall included repairs to welding, and coating repainting etc. The repaired joint shall be subjected to a retest. No section shall be accepted put in a perfectly water tight conditions and retested satisfactorily. The entire cost of testing, retesting etc. shall be paid under the relevant items of Bill of Quantities. The Contractor shall make all arrangement for all labour, pumps, pressure gauges equipment, etc. No main valve or cross connections either on the new or existing main shall be operated by the Contractor, and only the Hydraulic Engineer's or Project Department staff shall operate the same. The Contractor shall arrange for labour required for operating the air valves, etc., Municipal labour employed for the test shall be charged to the Contractor.

The hydraulic testing of the water main will be carried out fully, or partly as per the site conditions. If any leakages are observed during the defects liability period due to defective workmanship, the same will be rectified through Hydraulic Engineer's Department as the work on live water main is done by Hydraulic Engineer's department only. The charges of repair will be recovered from the amount of retention money. Repairs on live water mains are to be carried out immediately to avoid wastage of water and other problems such as disruption of water supply, traffic etc. In view of this, it will be very difficult to give prior intimation to the Contractor. As such, the cost of repairs as per Hydraulic Engineer's Department's bill will be recovered from the retention money withheld in deposits without giving any prior intimation. The Contractor shall not challenge or claim any extra for such action on the part of Municipal Corporation.

2.1.11 Underground Pipeline-Laying

2.1.1101 Handling of pipes and Specials

Coated pipes and specials that are to be stored on supports shall bear on the uncoated ends only. If bearing on coating is employed the supports shall be not less than 20 cm (8 inches) wide and so arranged to prevent damage to the coating.

During handling of the pipes and fittings, coating shall be protected not less than 20 cm wide and placing strips of heavy belting or other approved sheet materials not less than, 20 cm wide under all ropes or fastening.

2.1.1102 Sand Bedding

Where specified the sand bedding to required thickness, and level shall be provided below pipe, prior to laying the pipe in trenches. It shall be compacted with a light hand rammer. Any reduction in thickness due to compaction shall be made up by adding sand during ramming. For the purpose of the bedding under this item only screened fine sand of grain size not larger than 2 mm shall be used. The sand shall be clean, uncoated and free form clay lumps, injurious amounts of dust, soft particles, organic matter, loam or other deleterious, substances.

If the sand supplied is unclean it shall be washed. In no case shall sand containing more than 3.5 % by dry volume or 5% by wet volume of clay, loam or silt be accepted. Tests specified for determining silt in sand and organic impurities as described in IS:383 shall apply. Sieved and washed sand shall be stored on the works in such a manner as to prevent intrusion of any foreign matter, including coarser particles of sand or any clay or metal or chips. Tests as indicated above shall be performed if called for by the Engineer at the expense of the Contractor.

During the work of providing sand bedding and laying the pipeline over it, loose material from the sides or edges of the trench shall be prevented from falling inside the trench, by providing shoring and taking other measures. Also where necessary, trench shall be kept dry by pumping out seepage water continuously.

2.1.1103 Lowering and Jointing

The pipe shall be lowered into the trenches by removing only one or two struts at a time. It shall be seen that no part of the shoring is disturbed or damaged and, if necessary additional temporary struts may be fixed during the lowering operations. It shall also be necessary to see that the Gunite coating of pipe is not damaged in anyway during the lowering and assembling. After the pipe is lowered into the trench, it shall be laid in correct line and level by using the levelling instruments, sight rails, theodolite, etc. care shall be taken to see that the longitudinal joints of two consecutive pipes at each circumferential joints are staggered by 90°. While assembling the pipes, the ends shall have to be brought close enough to leave a uniform gap not exceeding 4 mm. If necessary, a marginal cut may be taken to ensure a close fit of the pipe faces. For this purpose, only experienced cutters who can make uniform and straight cuts, shall be permitted to cut the faces of the pipes. No extra payment shall be made for such marginal cutting. There shall be no lateral displacement between the pipe faces to be joined. If necessary, spiders from inside and tightening rings from outside shall be used to bring the two ends contact and alignment. It may also be necessary to for this purpose. In no case shall hammering or longitudinal slitting be permitted. When the pipe is properly assembled and checked for correct line and level, it shall be firmly supported on wooden beams and wedges and tack welded. Some portion of the trench may be refilled at this stage so as to prevent the pipeline from losing its alignment. The tack welded circumferential joints shall then be welded fully. Only experienced welders, who shall be tested from time to time shall be permitted to carry out the welding work. For welding, refer to clause 2.1.1107.

On completion of the pipe jointing and external protection, the trench and the welding pits shall be cleaned of guniting rebound. The welding pits shall be filled and compacted in 150 mm layers with the bedding material.

Backfilling shall be carried out as detailed in clause 2.1.1106.

2.1.1104 Providing Steel Props Inside The Pipeline (Dia. 1200 mm and above)

In order to effectively provide cement mortar lining to the inside of the pipes and to avoid difficulties during the work, it is necessary that the roundness of the pipes is maintained circular till the lining work is taken up. To achieve the same, steel adjustable screw type props of screw or similar approved make consisting of minimum six legs shall be fixed inside the pipe. The deflection of the Pipe should be limited to 2% of the average diameter. In no case shall the limit be exceeded, even under the full load, in case of pipes laid underground. The design and drawings of the props that the contractor intends to use should be got approved by the Engineer before starting the work. While laying the pipes underground, the Contractor shall provide this propping arrangement from inside to maintain circularity. These props shall be fixed vertically and at intervals of not more than 1.8 metres or as directed by the Engineer. In case the Engineer finds it necessary, they will have to be fixed in any position. The props should be kept in position at least for three days after the encasing of the pipe in that section is completed or till refilling is done to the full eight of fill over the pipe in case the pipes are not encased. The props shall be removed only after obtaining permission from the Engineer. The height of earth fill over the pipe top shall normally be such as to avoid floatation under submerged condition and to have a minimum earth cushion of about 1.25 metres over the pipe whichever is greater. It is also necessary that, in case of buried pipe, adequate side supports from the backfilled materials is developed to keep the diametral deflection within the specified limits. Backfilling of the excavated trenches, particularly below the pipe and along the sides shall, therefore, have to be done with proper care and compaction as desired. No separate payment shall be made for use of props.

2.1.1105 Precautions against Floatation

When the pipeline laid underground or above ground in a long narrow cutting gets submerged in water collected in the trench of cutting it is subjected to an uplift pressure due to buoyancy and is likely to float if completely or partly empty. In the design of pipelines,

provision is made to safeguard against floatation providing sufficient overburden or by providing sufficient dead weight by means of blocks, etc.

In the case of works extending over one or more monsoon seasons, however special care and precautions are necessary during the progress of work on this account. The Contractor shall close down pipe laying operations well in time for the monsoon. The work of providing blocks, refilling the earth to the required level, compacting the same, etc. shall always be done as soon as the pipeline in the cutting has been laid.

The Contractor shall see that the water shall not be allowed. to accumulate in open trenches. Where work is in an incomplete stage, precautionary work, such as blank flanging in the open ends of the pipeline and filling the pipeline with water etc. shall be taken up as directed by the Engineer.

Such works shall be to the Contractor's account and no separate payment shall be made for the same. The Contractor’s rate for pipe laying shall be deemed to include such precautionary measures against floatation.

Protection of the pipeline against floatation during the Contract Period shall be the responsibility of the Contractor. Should any section of the pipeline float due to his negligence, etc. the entire cost of laying it again to the correct line and level shall be to his account.

2.1.1106 Refilling of Trenches

On completion of the pipe laying operations in any section, for a length of about 100m and while further work is still in progress, refilling of trenches shall be started by the Contractor with a view of restricting the length of open trenches. Pipe laying shall closely follow the progress of Trench Excavation and the Contractor shall not permit unreasonably excessive lengths of trench excavation to remain open while awaiting testing of the pipeline (for field testing of pipeline refer Clause 2 .7.8.5 of this Specification). If the Engineer considers that the Contractor is not complying with any of the foregoing requirements, he may prohibit further trench excavation until he is satisfied with the progress of laying and testing of pipes and refilling of trenches. Only soft earth and murrum of good quality free from stones larger than 75 mm in size and free from boulders, roots, vegetation, cinders, ashes, slag, refuse, rubbish, organic material etc., shall be utilised after the lumps are broken for filling in around the pipes for at least 30 cm all around for pipes less than 1200 mm diameter and D/4 for pipes greater than 1200 mm diameter. Filling shall be in layers not exceeding 150 mm and compacted to 25 percent of the maximum dry density as per part VII of IS:2720. The excavated material nearest to the trench shall be used first. Care shall be taken during backfilling, not to injure or disturb the pipes, joints or coating. Filling shall be carried out simultaneously on both sides of the pipes so that unequal pressure does not occur. Walking or working on the completed pipeline shall not be permitted unless the trench has been filled to height of atleast 30cm over the top of the pipe except as may for tamping etc., during backfilling work.

The remaining portion of the trench may be filled in with a mixture of hard and soft material free from boulders and clods of earth larger than 150 mm in size if sufficient quantity of good earth and murrum are not available. Filling in shall be done in layers not exceeding 225 mm in thickness accompanied by adequate watering, ramming etc., so as to be compacted to 95% of the maximum dry density as per part VII of IS:2720. Water contents of the soil shall be as near the optimum moisture content as possible. Regular measurement of the field dry density shall be taken by the contractor at various levels in the backfilling as required by specifications and as directed by Engineer. Any backfill which fails to achieve the required degree of compaction shall be re-excavated and replaced and re-compacted to the required density , all at contractor’s cost. The trench shall be refilled so as to build up to the original ground level, keeping due allowance for subsequent settlement likely to take place.

To prevent buckling of pipe shell of diameters 1200 mm and above, pipes shall be strutted from inside while the work of refilling, is in progress.

For pipelines of diameters below 1200 mm strutting shall be done from inside at either end of the stretch of the pipeline under refilling, by means of strong spiders which shall be sufficiently stiff to resist all deformation for which no extra, payment will be made.

Strutting shall be done by means of strong spiders having at least 6 arms which shall be sufficiently stiff to resist all deformation. Spiders shall be provided at a maximum interval of 2m.

The Engineer shall, at all times, have powers to decide which portion of the excavated materials shall be for filling and in which portion of the site and in what manner it shall be so used.

If any material remains as surplus it shall be disposed of as directed by the Engineer. If the Contractor fails to remove the earth from site within the period specified in a written notice, the Engineer may arrange to carryout such work at the Contractor's risk and cost or may impose such fine for such omission as he may deem fit. Particular care shall be taken to keep the trench dry during the entire refilling operation.

If suitable material for refining is not available for excavation the Contractor shall bring earth, murrum of approved quality as directed by the Engineer.

Regular measurement of the field dry density shall be taken by the Contractor at various levels in the backfilling as required by the Engineer.

No mechanical plant other than approved compacting equipment shall run over or operate within the trench until backfilling has reached its final level or the approval of the Engineer has been obtained.

Subsidence in Filling in : Should any subsidence take place either in the filling of the trenches or near about it during the maintenance period of 12 months from the completion of the Contract works, the contractor shall make good the same at his own cost or the Engineer may without notice to the Contractor, make good the same in any way and with any material that he may think proper, at the expense of the Contractor. The Engineer may also, if he anticipates occurrence of any subsidence, employ persons to give him timely notice of the necessity of making good the same, and the expenses on this account shall be charged to the Contractor.

2.1.1107 Welding Joints

As regards the welding work, the following points shall be borne in mind by the Contractor:

(a) The Contractor shall use approved make of standard electrodes depending on the thickness of plate and type of joint. He shall also use standard current and arc voltage required for the machine in use as per manufacturer's directions. Welding electrodes shall conform to I.S. 814 - "Specifications for covered electrodes for metal arc welding of mild steel (Latest Revision).

(b) Welded joints (other than for closing lengths) shall be of the butt welded type with an internal circumferential weld. However, pipes 900 mm and below in diameter shall be jointed with external welds and pipes larger in size will be circumferentially welded both internally and externally. All fillet welds shall have a throat thickness not less than 0.7 times the thickness of the pipe to be welded.

All parts to be welded shall have loose scale, slag, rust, paint and other foreign matter removed by means of a wire brush and shall be left clean and dry. All scale and slag shall be removed from each weld when it is completed.

(c) Gauging

Pipes larger in size, i.e. more than 900 mm diameter shall be welded internally and externally. At the time of internal welding, a `V' cut is made from inside of the pipes and after completing the internal welding with the required number of runs, the external welding (sealing run) is incumbent. Before starting the external welding (sealing run), the internally welded material in the joint will have to be cleaned by Gouging with Gas Flame. Gouging shall be done before starting the external welding (sealing run) and the rate of welding shall include the cost of gouging also.“ Gouging will also be carried out before rectifying the defective welding wherever necessary and as directed by the Engineer.

(d) Procedure

The welding of large pipes in the field shall comply with I.S. 816 and I.S. 823 (Latest Revisions). No field welding shall be permitted if there is rain or high wind.

Openings in the laid pipeline in the form of manholes made at suitable distances, for access into the pipeline for the work of cleaning, painting and repairs to the welds, etc. shall be closed by welding a new patch on the opening.

Such manholes should, as far as possible, be provided at the sides of pipelines; cutting at the crown of the pipe should be avoided. The following procedure should be strictly adopted while plugging the manholes by patch plating:

(i) The manholes shall be plugged by providing a patch plate cut from a separate strake of pipe of the same diameter. The old plate cut from the pipeline shall not be used for this purpose.

(ii) The edges of the new patch plate shall be properly shaped and the plate inserted in the opening by keeping a gap of 1.5 to 2.5 mm and tacked.

(i) The welding of the patch should be done in segments with proper sequence conforming to I.S. 823.

(e) Testing of Welding Joints

(i) The welded joints shall be tested in accordance with the procedure laid down in I.S. 3600 "Code of Procedure for testing of fusion welded joints and weld metals in steel". One test specimen shall be taken from at least one field joint out of any ten and shall be subjected to test.

(ii) The test pieces shall be taken out from the positions pointed out by the Engineer without any delay. They shall be machined and tested in a week's time.

(iii) The shape of the test pieces removed from the pipes shall be such that it will give a specimen of the required dimensions and, at the same time, leave a hole in the pipe with rounded corners. This hole shall be patched up by inserting and welding suitable size plates. Great care should be taken in preparing these plates so as to get a good butt weld. Procedure given in Clause 2.7.1107 (d) shall be followed.

(iv) After the jointing is completed, all protruding portions shall be chipped off and ground smooth and the unpainted portion of the pipeline near the field joint shall be thoroughly scraped and cleaned. Internal and external surface treatment shall be done as per the instructions of the Engineer.

(v) The entire cost of the test, including taking out test samples, machining the test pieces, transport to and from the laboratory and testing them in a laboratory, the cost of patching up the test piece hole in the pipe, payment of all testing fees, cleaning and painting the same, shall be borne by the Contractor. The tests shall be carried out in some Government or Semi-Government institute approved by

the Engineer. This shall be arranged by the Engineer entirely at the Contractor's cost.

(vi) The following tests shall be made :

1. Tensile Test, : The test specimen taken across the weld shall be shaped in accordance with I.S. 823. The specimen shall be taken from the end of the pipe or at any field joint in the pipe as directed by the Engineer and shall be cut such that the weld lies approximately in the middle of the specimen length. The specimen shall be machined. The protruding welded portion from both inside and outside shall be removed by machining or grinding before the specimen is tested.
2. At least one field joint out of every ten shall be subjected to test by taking out a specimen. If a test specimen shows defective machining or develops flaws not associated with welding, it may be discarded and another specimen substituted. The welding joint shall show a strength not less than the minimum tensile strength specified for the plate.
3. Bend Test, : The bend test specimen shall be prepared in the same way as that for tensile test and tested in the presence of the Engineer. The specimen shall withstand being bent cold through 180" around a pin, the diameter of which is equal to 4 & 1/2 times the thickness of the plate, without developing cracks. In making the bend test, the side of the specimen representing the inside of the pipe shall be placed touching the pin.
4. Re-test, : If the results of the tensile or bend test of any lot do not conform to the requirements specified, retests of two additional specimens from the same section shall be made, each of which shall conform to the required specifications. In case of failure of one or both, extensive gouging (scooping out) and repairing shall be carried out as directed by the Engineer before the lot can be accepted.

(vii) The welder / operator shall be held responsible for any failure of the joint. Since factors such as current, arc voltage, quality of electrodes, etc. are already determined and controlled, the failure is due only to the carelessness and negligence of the welder. For the first failure, the welder/operator shall be warned and for the second failure, he shall be removed from the work and replaced by another approved welder / operator. The joints or a portion thereof shall be gouged and repaired to the satisfaction of the Engineer. In order to maintain a good standard in welding, all welders shall be tested before they are entrusted with any job. Further, they shall be periodically tested at intervals of six months.

(viii) A complete record shall be maintained by the Contractor showing the names of welders and operators working on each individual joint. The work shall preferably be carried out by a pair of welders so that, by observing proper sequence, distortion can be avoided. A joint entrusted to a particular individual or pair shall be as far as possible completed by them in all respects, including the sealing run. No helper or other unauthorized unqualified person shall be permitted to do any welding work whatsoever. In case of any infringement, the person concerned shall be penalised as directed by the Engineer.

2.1.12 Cleaning, Disinfecting And Commissioning Of The Pipeline

Upon completion of a newly laid main, the main shall be disinfected as directed by the Engineer.

The main shall be flushed prior to disinfection except when the tablet method is used. After initial flushing, the hypochlorite solution shall be applied to the water main with mechanically or electrically powered chemical feed pump designed for feeding chlorine solutions. For small applications, the solution may be fed with a hand pump.

In the case of main of large diameter, water from the existing distribution system or other approved source of supply shall be made to flow at a constant measured rate into the newly laid pipe line. The water shall receive a dose of chlorine also fed at a constant measured rate. The two rates shall be proportioned so that the concentration in the water entering the pipe line is maintained at no less than 300 mg/l. The chlorine shall be applied continuously and for a sufficient period to develop a solid column of 'slug' of chlorinated water that will as it passes along the line expose all Interior surfaces to a concentration of at least 300 mg/l for at least 3 hours. As the chlorinated water flows past tees and crosses related valves and hydrants shall be operated so as to disinfect the appurtenances.

In the case of newly laid mains in which scrupulous cleanliness has been exercised the tablet method can be adopted and in this method, the initial flushing is dispensed with. The calcium hypochlorite tablets are placed in each section of pipe and also in hydrants, hydrant branches and other appurtenances. The tablets shall be attached by an adhesive and must be at the top of the main. The main shall then be filled with water and the water shall remain in the pipe for atleast 24 hours.

After the applicable retention period, the heavily chlorinated water shall be flushed from the main until the chlorine concentration in the water leaving the mains is not higher than that generally prevailing in the system or less than 1 mg /l .

After final flushing and before the water main is placed in service, a sample or samples of water shall be collected from the end of the line and tested for bacteriological quality and shall show the absence of coliform organisms. If the initial disinfection fails to produce satisfactory samples, disinfection shall be repeated until satisfactory samples are obtained before the main is placed in service.

The Contractor is expected to carry out the disinfection work as a part of laying the pipes and his rates for laying the pipes should include the disinfection and other connected works till the main is placed in service, unless otherwise specified in the schedule.

No separate payment shall be made for the items covered under this clause.

2.1.13 Measurement

The measurement for pipes shall be on running metres of net length along the centre line of the pipe as laid excluding the length of specials and appurtenances.

2.1.14 Blank Flanges

Blank Flanges shall be provided at all ends left unattended for the temporary closure of work, and also for commissioning a section of the pipe line or for testing the pipeline laid. For temporary Closures, non pressure blank flanges consisting of mild steel plates, tack welded at the pipe ends may be used. For pipes subjected to pressures, the blank flanges domes suitably designed as per Engineer’s requirement shall be provided.

2.1.15 Stiffner Rings

The stiffener rings shall have to be provided wherever directed. The contractors shall weld the same to the pipes with one circumferential run on each side. The pieces of the rings shall also be welded to each other as directed.

If the stiffener rings are fixed in position after the pipes are lowered into the trench, the welding of the stiffener rings shall be carried out in the same welding pit excavated for the

field joints and therefore no extra payment will be made for the excavation of the pit for welding of the stiffener ring.

Stiffener rings shall be paid on MT basis and welding under relevant item for field welding.

2.1.16 Straps:

Wherever pipe laying work is done from two faces and /or has to be done in broken stretches due to any difficulty met with at site, the final connection has to be made by introducing straps to cover gaps up to 300mm in length. Straps shall also be provided as per the procedure of fixing expansion joints by the method described in clause 2.8.6 under “Above-Ground Pipelines”. Such straps shall be fabricated in the fields by cutting pipes, slitting them longitudinally or slipping them over the ends to be connected in the form of a collar. The collar shall be in two halves and shall have its inside diameter equal to its outside diameter of the pipe to be connected. A minimum lap of 80mm on either ends of the pipe shall be kept and fillet welds shall be run both internally as well as externally for circumferential joint. In case of pipes 900mm dia and below internal fillet weld may not be provided if so permitted by the Engineer. The longitudinal joints of the collar shall be butt-welded. All fillet welds shall have a throat thickness of not less than 0.7 times the width of weldings.

2.1.17 Radiography of Welded joints:

2.1.1701 General:

Shop welds in pipes, specials shall be radiographed as per requirements mentioned below :

As soon as practicable, after welding is done minimum 15% (fifteen percent) length of the weld at random for each pipe shall be radiographed, to detect welding defects as per the requirement of IS 2598:1966 and as directed by the Engineer. This 15% sampling will be at random but ensure 100% coverage of junctions of longitudinal and circumferential joints. If the results of such radiography fail to conform to the requirements, the Contractor shall carry out as directed additional or 100 percent radiography test for the pipe at the Contractor's cost to the satisfaction of Engineer.

The provision for conducting radiography shall apply to pipes of diameter 1200mm and above.

For specials like bends, tapers, tees and Wyes radiography test shall be conducted for 100 percent length of welds.

The weld ripples or weld surface irregularities, on both inside and outside shall be removed by any suitable mechanical process to a degree such that resulting radiographic contact due to any remaining irregularities cannot mark or be confused with that of objectionable defect. The radiograph shall be made in strict accordance with the latest requirements and as per the latest and most efficient technique either with X-ray or gamma ray equipment.

The radiographs are to be marked in such a way that the corresponding portion of the welded seam can be readily identified. All radiographs will be reviewed by the Engineer to identify the defect and determine those which must be removed. Defects that are not acceptable shall be removed by chipping; machining or flame gouging to sound metal and the resulting cavities shall be welded. After rectification, the joint is to be radiographed again to prove the quality of the repair. The radiographs will be judged as acceptable or unacceptable by the Engineer based on the latest standards prescribed by Indian Standard specification.

All X-ray shall be made with equipment and by personnel furnished by the Contractor. Films shall be developed within 24 hours of exposure and be readily accessible at all times for inspection by the Engineer. The Contractor shall provide for the use of the Engineer suitable X-ray viewing equipment. X-ray films shall be properly maintained by the contractor and shall be handed over to the department on completion of the Contract. All films shall be identified

by the No. and chart prepared indicating location of the joint each X-ray photo represents, In the event of additional radiographic inspections required of any work associated with the pipe erection, such inspection shall be performed by the Radiographer at the discretion of the Engineer.

2.1.1702 Radiographic Inspection of welded joints

All welded joints to be radiographed shall be examined in accordance with IS 2595:2008-Code of Practice for Radiographic Testing

IS 4853:1982-Recommended Practice for Radiographic Examination of Fusion Welded Circumferential joints Steel Pipes.

IS:1182:1983-Recommended Practice for Radiographic Examination of Fusion Welded Butt-joints

IS:2598:1966-Safety Code for Industrial Radiographic Practice.

The reinforcement on each side of all butt welded joints shall not exceed 1.5 mm.

A complete set of radiographs and records as described in IS: 2595:2008 Clause 14, for each job shall be retained by the Contractor and kept on file for a period of at least five years.

Radiographers performing radiograph shall be qualified in accordance with SNT-TC-1A. Supplements and Appendices “Recommended Practice for Non-destructive Testing Personnel Qualification and Certification” published by the American Society for Non-destructive Testing as applicable for the technique and methods used.

Final acceptance of radiographs shall be based on the ability to see the prescribed penetrometer image and the specified hole.

Sections of welds that are shown by radiography to have any of the following types of imperfections shall be judged unacceptable and shall be repaired.

(a) Any type of crack, or zone of incomplete fusion or penetration,

(b) Any elongated slag inclusion which has length greater than 6 mm,

(c) Any group of slag inclusion in line that have an aggregate length greater than thickness in a length of 12 times thickness, except when the distance between the successive imperfections exceeds 6L where L is the length of the longest imperfection in the group,

(d) Rounded indications in excess of that specified by the acceptance standards given earlier.

2.1.18 Cement Mortar Lining For Internal Surface Of Pipeline

2.1.1801 Scope

This Specification covers the requirements of providing materials and application of in-situ cement mortar lining by mechanical and/or hand application to the internal surfaces of pipeline at surface to be installed. Pipes below 900mm diameter shall not be lined but painted as per specifications. After completion of field hydraulic test of the pipeline, the Contractor shall take upthe in-situ cement mortar lining to the internal surface of the pipeline. The work shall be started only after obtaining the written approval of the Engineer in this respect.

2.1.1802 Applicable Codes and Specifications

The following specifications, standards and codes in addition to those listed in Clause 2.7.2 of this specification are made a part of this specification. All standards, specifications, codes of practices referred to herein shall be the latest edition including all applicable official amendments and revisions. In case of discrepancy between this specification and those referred to herein, this specification shall govern.

1) AWWA C602-76 - American Water Works Association (AWWA) Standard for Cement Mortar

Lining of Water Pipelines - 4 in. and larger - In Place.

2) IS 3696:1991 - Safety code for scaffolds and ladders (Part 1 & II)

3) ASTM - C40 - Test for organic Impurities in Sands for Concrete.

2.1.1803 General

Engineer shall have the right to inspect the source/s of material/s, the operation of procurement and storage of material, Cement mortar batching ad mixing equipment and the quality control system. Such an inspection shall be arranged and the Engineer's approval obtained prior to starting of lining work.

2.1.1804 Method of Application

All lining work shall be done by machine/hand application. If there are areas where the lining can be done by machine but cannot perform finishing, then the bidder in his bid shall indicate such areas. By prior approval, of Engineer, these areas may be machine sprayed and hand troweled.

2.1.1805 Workmanship

All works shall be performed in a thorough and workmanlike manner by trained personnel with previous experience under the supervision of experienced men skilled in the in-situ application of cement-mortar lining to pipelines.

2.1.1806 Programme of Lining And Plant And Equipment :

The plant and equipment Proposed by the Contractor for Carrying out the cement mortar lining application shall be furnished along with the Bid. The contractor shall also furnish the methods he proposes to adopt.

2.1.1807 Materials of Construction

a) Cement

Cement required for mortar lining shall be "Ordinary Portland Cement" conforming to IS-269:1989.

b) Admixture

To improve workability, density and strength of the mortar, admixtures as approved by the Engineer may be used by the Contractor at his own cost. No admixtures shall be used that would have a deleterious effect on water flowing in the pipe, which is required for drinking Purposes.

c) Sand

Sand shall consist of inert granular material. The grains shall be strong, durable, and uncoated. The sand shall be well graded and shall pass a 1.18 mm mesh screen (ASTM No.16) with not more than 5% passing 150 micron sieve (ASTM No.100). Sane shall be free from injurious amounts of dust, clay, lumps, shale, soft or flaky particles mica, loam, oil, alkali, and other deleterious substances. The total weight of such substances shall not exceed 3 percent of the combined weight of the substances and the sand that contained them. Limitations shall apply to specific substances as follows:

Substances Percentage by weight	Maximum allowable
Shale	1
Clay lumps	1

Mica and deleterious

Substances other than Shale and clay lumps 2

Organic impurities – Sand shall not show a colour value darker than the reference standard colour solution prepared as required by ASTM 6.40 “Test for organic Impurities in Sands for Concrete”

d) Water

Water for mixing mortar shall be clean and free from injurious amounts of mud, oil, organic material or other deleterious substances.

e) Wire Mesh:

Wire Mesh of 6mm dia to be provided for hand lined vertical pipes.

2.1.1808 Design of Lining

a) General

Composition of mortar for the lining shall be composed of cement, sand and water mixed to such consistency as to produce a dense, homogenous lining that will adhere firmly to the pipe surface. Contractor shall take prior approval for the admixtures he proposes to use.

b) Proportion

Proportions of cement and sand shall be 1 part of cement to 1 parts of sand by volume. Slight modifications in composition could be made at site to suit the characteristics of the sand used. Each bag of cement shall be weighed and converted into volume for its use. Admixtures, if permitted, shall be used in strict accordance with the manufacturer’s recommendations. The minimum cement content shall be 1026 Kg / m3 and water cement ratio of between 0.3: 1 and 0.45:1 by mass.

c) Water Content:

Water content shall be the minimum that is required to produce a workable mix, with full allowance made for water collecting on the interior of pipe surface.

d) Mixing:

Mortar shall be well mixed and of proper consistency to obtain a dense, homogenous lining. Where premixed mortar is used, it shall be done so before initial set.

e) Thickness of Lining

The variation in thickness of Cement mortar lining for various diameters of pipe shall be as mentioned in the table below with a maximum plus tolerance of 3 mm.

Diameter of Pipeline	Nominal Thickness of Lining
Above 2250mm dia	12mm
1200mm to 2250 mm	10 mm
Below 1200mm	3 mm

2.1.1809 Method of Construction

a) Access Openings

Only such openings as indicated by the Contractor and approved by Engineer shall be provided in the pipe lines. After lining is completed, closure pieces will be welded to the pipe. Mortar lining of closure pieces and adjacent area shall be included in the rates quoted for the mortar lining work.

b) Preparation of Pipe Surface

The interior surface of pipe to be lined shall be cleaned to remove all rust, chemical or other deposits, loose and deteriorated remains of old coating materials, oil, grease, and all accumulations of water, dirt, and debris. The cleaning of the surface shall be carried out by the use of suitable chemical or mechanical means with the approval of Engineer. The extent of cleaning shall be to the satisfaction of the Engineer.

All loose mill scale, dirt, rust, and accumulation of construction debris shall be removed from the interior off the steel pipeline. The pipeline shall be cleaned by use of a power driven cleaner incorporating revolving brushes on rotating arms. After this cleaning the pipe shall be flushed with potable water and all standing water removed.

Surfaces applied with cement wash shall be cleaned with wire brush manually to the satisfaction of the Engineer.

Blast cleaning shall be followed for pipe surfaces to be treated with Inertol (or approved equivalent paint), coal tar (or bituminous) enamel with or without wrapping or wherever directed or when the pipe surfaces are badly rusted. The procedure followed for blast cleaning is as follows:

All oil, grease on the surface of the pipe shall be first removed by applying a suitable metal cleaning solution and wiping with clean rags. All foreign matter which cannot be removed by this blasting process shall be removed by any other suitable means approved by the Engineer.

All metal surfaces shall be thoroughly cleaned by blasting. Blasting operations shall remove all rust, scale and other impurities from the surface exposing the base metal overall, presenting a greyish appearance, however slight shadows, streaks or discolouration caused by rust stain or mill scale oxide need not be removed. The blast cleaned surface shall be primed immediately after blasting is over. Blast cleaned surfaces that rust before a priming coat could be applied shall be cleaned again of all rust by wire brushing or if directed by the Engineer, they shall be re-blasted at contractor's cost. The Contractors shall avoid strictly, keeping the prepared steel surfaces overnight and painting them the next morning. Blasting should be done at a pressure of 5.62 kg/sq.cm(80psi) at the compressor end and at 4.93 kg/sq.cm (70 psi) at nozzle end so as to get a good clean surface after removing the rust. This pressure should be maintained. Improper jointing of hose pipes and resultant reduction in pressure at nozzle end shall be checked and avoided. The sequence and the programme of blast cleaning and application of zinc rich epoxy primer for more than two hours. Greater care shall be taken in blasting particularly at field joints for getting grey surface. After cleaning the blasted surface shall be inspected to see that no rust is left out. Primer coat shall then be allowed to be applied. Torches may be used to inspect the surface, Re-touching shall be done wherever directed.

c) Machine Application of Mortar Lining Clean Up Ahead of Machine

Immediately prior to the travel of the lining machine through the pipeline, all foreign material shall be removed. This includes sand and loose mortar that might have accumulated since the work of preparation of surfaces was completed.

d) Lining Procedure

The lining shall be placed by centrifugal method in one course by a machine travelling through the pipe and discharging the mortar at a high velocity over all pipe sections and long

radius bends. The discharge shall be from the rear of the machine so that the freshly applied mortar will not be marked. The rate of travel of the machine and the rate of mortar discharge shall be mechanically regulated so as to produce uniform thickness throughout. The mortar must be densely packed and shall adhere the pipe wherever applied.

2.1.1810 Surface Finish

Mortar lining shall be mechanically trowelled except for the places where hand trowelling is expressly permitted by the Employee.

a) Trowelling Lining

The lining machine shall be provided with attachments for mechanically trowelling the mortar. Both the application and trowelling of the mortar shall take place at the rear of the machine so that the freshly placed and trowelled mortar will not be damaged. The trowel attachment shall be such that the pressure applied to the pipe will be uniform and produce a lining of uniform thickness with a smooth and even finished surface free of spiral shoulders. The finished surface of machine placed and trowelled linings in pipe shall be examined according to the procedures in clause 2.7.910.b

b) Examination Procedure

In the stretch of pipe that has been lined and trowelled in each day's run, ten places shall be selected in straight sections of the pipe by the Engineer. In each of the ten places the thickness of the lining shall be measured as directed by the Engineer. Thickness of lining shall be ascertained frequently during placing of mortar and trowelling. Hair cracks or cracks upto 0.25 mm width in saturated linings and not over 300 mm in length are acceptable.

c) Untrowelled Lining

The finished surface shall be smooth and regular except that it may exhibit a slightly dimpled appearance. Edges or uneven build up caused by irregularity in the travel route of the machine will not be allowed.

2.1.1811 Hand Application of Mortar Lining

Handplaced mortar shall have a uniform and smooth surface with smooth transitions to adjacent machine placed linings

Cement mortar lining of bends, specials, areas closely adjacent to valves and other such places where machine placing may not be practical shall be performed by hand. The Engineer may order the correction for any defect by hand application.

Cement mortar for hand work shall be of the same materials at the mortar for machine placed lining.

The areas to be lined shall be thoroughly cleaned as specified earlier and, If necessary, shall be moistened with water immediately prior to placing the hand-applied mortar.

Steel finishing trowels shall be used for the hand application of cement mortar, except at bends the outer edges of hand trowelled areas may be brushed in order to reduce the abutting offset.

All hand finishing work in a section of the pipeline shall be completed within 24 hours after completion of the machine application of mortar lining to that section. If necessary, application of mortar lining by machine shall be delayed or stopped to assure compliance with this schedule.

2.1.1812 Special requirements at Laterals and Service connections

Laterals and connections to the pipe that is being lined shall not be left obstructed by the lining operations.

Before the lining is placed, the openings in the pipeline leading to air valves, blowoff, manholes and appurtenances, as well as to laterals and connections that transmit pressure or carry water from the pipeline, shall be temporarily covered or plugged with suitable devices. These shall be removed later without damaging the cement-mortar.

2.1.1813 Curing

Curing shall commence immediately after completion of the mortar lining and hand finishing of a section of pipeline. This shall, however, not be later than 8-hours after mixing of mortar. The lining shall be kept continuously in moist condition for a period of 14 days. During the operations of lining, finishing and curing, exterior surface of the pipe exposed to sunlight shall be sprinkled with enough water to keep the pipe cool. Open ends of pipes shall be suitably closed so as to maintain a moist atmosphere and prevent draught. Curing of mortar lining and simultaneous cooling of the pipeline externally shall be continued even beyond the period of 14 days as directed by the Engineer.

2.1.1814 Tests of Cement Mortar used for Lining

Test blocks of the same material as used for the lining shall be made in 150 mm cube moulds and subjected to Works cube crushing tests. Each block shall be removed from its mould as soon as practicable and cured under the conditions of temperature and humidity identical with those in which the lining of the pipe is cured. The number of tests shall be at least 4 cubes for each age and each water cement ratio. The works cube strength of the test cube shall not be less than 300 Kg/sqcm after 28 days of curing or 170 Kg/sqcm of 7 days of curing. The density of the test cube shall not be less than 2300 Kg/m3

2.1.1815 Inspection

a) Responsibility of Engineer and Contractor

The entire procedure of applying cement mortar lining shall be subject to continuous inspection by the Engineer but such inspection shall not relieve the Contractor of his responsibility to furnish material and perform work in accordance with this specifications.

b) Defective Lining

Defects in lining including but not restricted to sand pockets, voids, oversanded areas, blisters, cracked and dummy areas, and thin spots shall be removed, and the area shall be repaired by hand application to the full required thickness of the mortar lining. Defective areas encompassing the full diameter of the pipe shall be replaced by machine wherever practical. Defective lining rejected at the time of lining shall be removed before initial set of the mortar. Defective lining rejected after initial set shall be replaced or repaired by the most practical method as determined by the Engineer, at no extra cost to the Corporation.

c) Guarantee

If on examination by the Engineer of the cement-mortar lining work within a period of 3 years after completion and acceptance of the Contract Work reveals evidence of defective materials or workmanship as defined in this specification but not limited to the same, then the Contractor shall perform the remedial work at his own expense in a manner acceptable to the Engineer.

End of Section 01021

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SECTIONS **NO.OF PAGES**

SECTION 02000 SITE WORK

PART 1 - GENERAL

1.01 Governing Conditions:

A. The General Conditions, Particular Conditions, Contract Forms and the requirements of Division 1 herein before specified, in addition to any and all Addenda, apply to and govern each Section of this Division.

B. This Section covers the general requirements for this Division and shall be read in conjunction with other Sections in this Division.

C. This Section governs the work of other Sections in this Division.

1.02 Work Included:

A. The work of this Division includes, but is not necessarily limited to, the provision of: all labour, materials, tools and equipment to carry out the following

1. Clearing and grubbing.
2. Removal and stockpiling of topsoil for future use.
3. Construction of access roads.
4. Excavation and backfilling for structures.
5. Sheeting, shoring and bracing of excavations, including dewatering as required.
6. Excavation and grading for roadways and parking areas, footings, foundations and slabs on grade and excavation for all piping, manholes and other services. The term excavation includes rock excavation.
7. Construction of temporary structures.
8. Construction of new structures including finishing.
9. Installation of process piping, sanitary, storm and process drains, maintenance chambers, valve chambers, plumbing, sub-drains and other piping at the sites including appurtenances.
10. Demolition and disposal of unused existing structures, piping, grating, hand railing and other facilities designated for removal.
11. Supply, placement and compaction of approved fill to final grades.
12. Removal and disposal of excess or unsuitable material, including rock, and supply of suitable backfill material as required.
13. Removal and disposal of unstable or unsuitable material from below foundation elevations and supply and placement of concrete to support the RCC foundation.
14. Supply, placement and compaction of foundation bedding.
15. Supply, installation and removal of temporary fencing including gates as specified.
16. Construction of concrete and gravel driveways.
17. Restoration of seeded areas, asphalt and gravel driveways and parking lots.
18. Restoration of fine grading of areas disturbed by construction activities. Provision of positive drainage as well as satisfactory blending with the existing grades as required throughout the disturbed areas.

19. Refurbishment and face lifting of existing structures.

1.03 Co-ordination:

A. Co-ordinate with the work of other Divisions before installing work included in this Division. If work is installed without co-ordination with other works, the Engineer may direct that such work be removed, relocated and/or modified as necessary. Comply promptly with the Engineer's requests. Complete any correction and/or additional work, as directed by the Engineers at no additional cost to the BMC.

B. For coordination requirements refer to Section 01003.

1.04 Submittals:

A. Submit drawings in accordance with Section 01007 and AS-BUILT drawings as per Section – 01016

B. Identify and submit existing Utility Plans for Engineers review.

1.05 Codes and Standards:

A. The applicable standards established by the Bureau of Indian Standards govern the materials and workmanship employed in the manufacture of all equipment/items.

B. Where provisions of the pertinent codes and standards conflict with these Specifications, Drawings and Datasheets or with each other, comply with the more stringent provision.

C. Use the latest issue of Standards.

1.06 Definitions:

A. The term "utility", as used herein, includes services such as gas, electricity, water supply, drains, and sewers.

B. The term “Inter-Connecting Piping” as used herein includes piping between units and the first joint outside the face of building/unit

C. The term “Gravity Main/ Bypass” as used herein includes piping from the valve chamber structure to Balancing Chamber /Nullah/storm water drain as shown on the drawings.

PART 2 - PRODUCTS

2.01 General:

A. Comply with the product requirements outlined in the individual Sections.

B. Select other materials not specifically described but required for the proper completion of the work of this Division subject to the approval of the Engineer.

PART 3 - EXECUTION

3.01 General:

A. Comply with the execution requirements outlined in the individual Sections.

3.02 Setting Out:

A. Be responsible for the setting out of the work, with reference to a baseline and a benchmark provided by the Engineer, per Section 01004.

3.03 Environmental Constraints:

A. Adhere to the environmental constraints set out in Division 1.

3.04 Site Conditions:

A. Refer to Section 01000 for site conditions.

END OF SECTION 02000

SECTION 02050 REMOVAL AND DEMOLITION

PART 1 -GENERAL

1.01 Reference:

A. Section 02000 applies to and governs the work of this Section.

1.02 Work Included:

A. Demolish structures within IPS site area which are not going to be used ensuring that no utilities or buildings that are to remain in operation are disturbed. Be responsible for removing debris from site.

B. After successful commissioning of the refurbished pumping station and related structures within IPS and their successful operation for 7 days, all incoming sewage flows will be transferred permanently to the new surge tank and then to the rising main.

C. The equipment and items shall be removed and disposed of off-site. If the dry/wet well are to be demolished the same shall be drained, cleaned and sterilized before being demolished to 1.0 metres below existing or ground level.

D. Removals and Demolition includes, but is not necessarily limited to, the following:

1. Obtain permissions from the relevant authorities and follow their requirements for removal and disposal of mechanical, piping, electrical and instrument equipment etc.

2. Removal and disposal of concrete, masonry, structural steel, other metals and other unwanted materials off-site in accordance with BMC requirements.

1.03 Related Work by other Divisions:

A. The following related work is covered elsewhere in the contract documents:

1. Division 1 - General Requirements

1.04 Alternatives:

A. This is not applicable in this section.

1.05 Submittals:

A. Prepare and submit to the Engineer, in accordance with Section 01007, a detailed execution plan for removals and demolition work, before commencing any demolition activity.

1.06 Codes and Standards:

A. The applicable standards established by the Bureau of Indian Standards govern the materials and workmanship employed.

1. IS 3696 Safety of scaffolds and ladders. Part-I and II
2. Safety Manual, Central Water and Power Commission
3. National Building Code of India-2005
4. IS 4130 - 1991 Safety Code for demolition of buildings (second revision)
5. I.S. 1200 - 1974 (Part III - 3rd Division) - Demolition and Dismantle.

B. Where provisions of the pertinent codes and standards conflict with these Specifications and Drawings or with each other, comply with the more stringent provision

C. Use the latest issue of Standards.

PART 2 - PRODUCTS

A. These are no products in this section.

PART 3 - EXECUTION

3.01 General:

A. Before commencing demolition of any structure, ensure that demolition does not endanger safety of other structures.

B. Start demolition of the structures, with the approval of the Engineer, as per detailed execution plan for demolition and removals work, including the sequencing plan and schedule.

C. Before demolition of structures, all equipment, piping, fittings, instruments, electrical items must be listed and removed and disposed off by the Contractor. Ensure there is no fire hazard caused by hazardous gases or electrical short circuit.

D. Grant the BMC the first right of refusal of items to be removed. Before proceeding with the demolition work, remove equipment and materials as designated by the Engineer to be retained by the BMC. Clean the equipment and material to the satisfaction of the Engineer. Store the equipment and material in a manner and in a location satisfactory to the Engineer.

E. Remove and dispose of remaining items off-site, in accordance with the regulations, the requirements of the BMC and as directed by the Engineer.

F. Provide final grading, placement of topsoil and seeding in accordance with Section 02480 Landscaping.

G. Fill depressions and excavated areas with approved fill, consolidate and grade as shown on the Drawings.

H. Clarification:

1. The Drawings do not intend to show every object existing on the project site.

2. Locate existing utility lines required to keep the existing plant running but that interfere with the execution of the construction of the new works. Either provide proper support or relocate the lines. After commissioning and the trial run of new pumping station, the redundant utilities to be dismantled and removed.

3.02 Temporary Fencing and Hoarding:

A. At the demolition working area, erect fencing to define such area. Agree with the Engineer on the extent of each working area.

B. Provide hoardings as per approved drawings/ and as required to protect the operations staff and the public.

3.03 Removal of Debris:

A. Remove and dispose of debris from the site and leave the site in a neat and orderly condition, to the satisfaction of the Engineer and in accordance with prevailing regulations. Penalty shall be imposed if the debris is not disposed properly.

B. Classify and dispose of wastes in accordance with applicable regulations under the Environmental Protection Act 1981 and the Air (Prevention and Control of Pollution) Act 1981

C. Do not burn debris on the project site.

3.04 Protection of the Environment:

A. Refer to Section 01010- Safety Requirements and Section 01011-Environmental Protection and Control.

B. Take all reasonable steps to protect the environment both on and off the Site and to avoid damage or nuisance to persons or to property of the public or others resulting from pollution, noise or other causes arising as a consequence of methods of operation for demolishing the existing structures.

C. Abide at all times by all existing enactments on environmental protection and rules made there under, regulations, notifications and by-laws of the State or Central Government, or local authorities and any other law, by-law, regulations that may be passed or notification that may be issued in this respect in future by the State or Central Government or the local authority.

END OF SECTION 02050.

SECTION 02100 SITE CLEANING AND GRADING

PART 1 - GENERAL

1.01 Reference:

A. Section 02000 applies to and governs the work of this Section.

1.02 Work Included:

A. Scope of Site Clearing and Grading work includes but is not limited to the following:

1. Clearing the site of all surface and subsurface structures, vegetation and debris.
2. Removal of trees as required.
3. Removal or relocation of existing utilities as required.
4. Excavation of unsuitable material.
5. Compaction of selected excavated materials or materials brought from elsewhere.
6. Disposal of surplus materials off the site including loading, transport, labour off-loading etc.
7. Grading of slopes, road relocations and preparation of sub-grades and drainage ways inclusive of constructing required embankments.

1.03 Related Work:

A. The following related work is covered elsewhere in the Contract Documents:

1.	Backfilling and filling	-	Section 02221
2.	Concrete	-	Division 3
3.	Steelwork	-	Division 5

1.04 Alternatives:

A. Not applicable for this Section

1.05 Submittals:

A. Submit drawings and product data in accordance with Section 01007 and AS- BUILT drawings as per Section 01016.

B. Identify and submit Utility Plans to the Engineer for review.

1.06 Codes and Standards:

A. The applicable standards established by the Bureau of Indian Standards govern the materials and workmanship employed in the manufacture of all equipment/items.

B. Where provisions of the pertinent codes and standards conflict with these Specifications, Drawings and Datasheets or with each other, comply with the more stringent provisions.

C. Use the latest issue of Standards.

PART 2 - PRODUCTS

2.01 Materials:

A. Select materials not specifically described but required for the proper completion of the Work of this Section, subject to the approval of the Engineer.

PART 3 - EXECUTION

3.01 Clearing Site of Large Trees, Structures etc.

A. Site Inspection:

1. Inspect the entire site carefully and obtain direction from the Engineer as to which loose items, if any, are to be removed and handed over to the Engineer before any work commences.
2. Locate existing utility lines and determine requirements for temporary supports, disconnecting and capping.
3. Locate existing active utility lines traversing the site and determine the requirements for their protection.

B. Clarification:

1. The Drawings do not intend to show every object or every tree, bush etc. existing on the project site.
2. Before starting any work under this Section, verify with the Engineer which objects, trees, bushes etc are to be removed and which objects to be preserved.
3. This include the removal of large trees, stumps and structures or parts thereof lying within the site of the Works as demarcated and shown on the Drawings with the prior permission of the concerned authority.

C. Demolition of existing concrete masonry or other structures to specified levels for site clearing shall be done but this work is covered in detail in Section 02050 – Demolition.

D. Blasting shall not be allowed.

3.02 Removal of Top Soil, Shrubs, and Other Vegetation, Refill and Re-compaction

A. All shrubs, vegetation and other plants shall be removed and cleared from the site. All debris and unsuitable material up to a depth of 30 cm shall be removed and the area refilled to correct grade with selected excavated material from the site or, if required, from approved borrow pits.

B. The quality and compaction of such fill or embankments shall be in accordance with the requirements of Section 02200.

C. Refill under roadways shall conform to the BMC's "Specifications for Road Works".

D. Refill and compact any existing pits, wells, existing dry-wells or other areas as shown on the drawings where the levels are below the required grade.

3.03 Relocation of Existing Utilities, Roadways, Waterways etc.

A. Disconnection of Utilities:

1. Before starting site operations, divert or disconnect or arrange for the diversion/disconnection of utility services. Utilities to be directed in accordance with utility company or agency involved.

B. Protection of Utilities:

1. Preserve in operational condition active utilities traversing the site that are designated to remain in operation until the new facilities have been constructed and commissioned.

2. Provide support structures for the existing utilities, as required, for the duration of the construction.

3. Refer to Division 1 for additional requirements.

C. All utilities known to exist within the site, such as water, storm and sewage mains, overhead or underground electric power cables, overhead or underground telephone wires or conduits, gas mains, etc., shall be shown on the Drawings by the Contractor. Remove and relocate such utilities necessary to be relocated permanently or temporarily after receiving permission from the Engineer.

D. In the case of utilities shown on the Drawings or discovered prior to commencement of the relevant portion of work, provide at least 7 clear days notice of the intention to start work at the site. In the case of any utility whose location is not shown on the Drawings or whose existence is unknown, but is encountered during the course of the work, immediately verify and inform the Engineer of such discovery and either relocate the utility or undertake to have it done with the consent of concerned authority.

E. Relocate or divert roadways or open drains as necessary within the site to the satisfaction of the Engineer.

3.04 Stockpiling Topsoil:

A. Strip topsoil that is clean, entirely free from debris and suitable for supporting vegetation, from the areas to be disturbed and stockpile for subsequent use. Agree with the Engineer on the suitability of topsoil for re-use.

B. Co-ordinate the stockpile locations with the Engineer who will designate stockpiling areas in the field.

C. Protect stockpiles from the effect of wind by covering with tarpaulins, as necessary and to the satisfaction of the Engineer.

3.05 Disposal of Surplus Material

A. Spread out the excavated top soil or save it for further use and dispose of trees, stumps, debris etc., off-sites at tipping sites, provided by BMC. Obtain licenses etc. for use of such sites

B. Classify and dispose of wastes in accordance with applicable regulations, under the Environmental Protection Act.

C. Remove and dispose of solids and debris from the site in accordance with regulatory requirements.

D. Grade and level the site to provide adequate drainage and leave the site in a neat and orderly condition to the satisfaction of the Engineer and in accordance with prevailing regulations.

E. Do not burn debris on the project site.

3.06 Provision of Additional Selected Fill

A. If adequate, quantity of approved earth fill is not available at site, the contractor to procure the same from borrows pits approved by Engineer.

END OF SECTION 02100.

SECTION 02150 CHAIN LINK FENCING

PART 1 - GENERAL

1.01 Reference:

A. Section 02000 applies to and governs the work of this Section.

1.02 Work Included:

A. The work shall generally be carried out as per these specifications, relevant drawings and as directed by the Engineer.

B. The work of this section includes, but is not necessarily limited to, the provision of: all labour, materials, tools and equipment to carry out the following

1. Clearing and grubbing.
2. Removal and stockpiling of topsoil for future use.
3. Construction of site fencing.

1.03 Related Work:

A. Section 02220 - Excavation

B. Division 5 - Metal work

1.04 Alternatives:

A. Not Applicable for this section

1.05 Submittals:

A. Submit drawings in accordance with Section 01007 and AS-BUILT drawings as per Section – 01016

1.06 Codes and Standards:

A. The following are applicable standards established by the Bureau of Indian Standards govern the materials and workmanship of Work under this Section:

1. IS: 2721 : Galvanized Steel Chain Link Fence Fabric

B. Where provisions of the pertinent codes and standards conflict with these Specifications, Drawings and Datasheets or with each other, comply with the more stringent provision.

C. Use the latest issue of Standards.

PART 2 - PRODUCTS

2.01 General:

A. Comply with the product requirements outlined in this Section.

B. Select other materials not specifically described but required for the proper completion of the work subject to the approval of the Engineer.

2.02 Materials:

A. M.S. Posts and Struts

All the M.S. posts/struts shall be free from rust, scale, cracks, twists and other defects and shall be fabricated to the required shape and size out of the specified sections. The posts and struts shall be conforming to relevant specifications stipulated here-in-before under relevant sections. All the posts and struts shall be of sizes and lengths as specified in the Tender Schedule and Drawing. The posts and struts shall have split ends for proper fixing and shall be embedded in the cement concrete of mix. 1:3:6 or as specified in the schedule. The exposed surfaces of the posts and struts shall be painted with two coats of synthetic enamel paint of approved make and shade over a coat of approved primer.

B. R.C.C Posts and Struts

All the posts and struts shall be of standard size as specified in drawings and schedule. These shall be casted on suitable places/platforms in cement concrete 1:2:4 (1 cement 2 coarse sand: 4 graded stone aggregate 10 mm. nominal size) as per relevant specifications stipulated here-in-before. The reinforcement shall be provided as shown in the drawings, as directed by the Engineer and specified here-in-before under relevant sections. The posts and struts shall be free from honeycombing, cracks and other defects.
After casting, the posts/struts shall be left at the same place and cured for a minimum period of 7 days. After 7 days curing the same shall be shifted to a levelled ground and stacked for further curing for 14 days. After 21 days of curing only, the posts/struts shall be transported to work site without any damage, for fixing in position.

PART 3 -EXECUTION

3.01 Spacing of the Posts and Struts:

A. The spacing of posts shall be 3 m. centre to centre unless otherwise specified or as directed by the Engineer, to suit the dimensions of the area to be fenced. Every 10th posts, last but one end posts, corner posts, and posts where the level of fencing changes in steps and end post when the fencing changes its direction shall be strutted on both sides, or as directed by the Engineer. End posts where barbed wire fencing is discontinued shall be strutted on one side only.

3.02 Fixing of M.S/R.C.C Posts and Struts:

A. Pits of size 45 x 45 x 45 cm. deep or of sizes mentioned in the drawings, shall first be excavated centrally in the direction of proposed fencing work, true to line and level to receive the posts. In case of struts, the pits shall be so excavated, as to receive minimum 15 cm. concrete cover at any point of the struts to suit its inclination or as shown in the drawing.

B. The pits shall be filled with a layer of 15 cm. thick cement concrete of specified mix. The posts and struts shall then be placed in the pits, the posts projecting to the specified height above ground level, true to line, plumb and position, by providing adequate supports temporarily, and cement concrete of specified mix shall then be filled-in so that the posts are embedded in cement concrete blocks of specified sizes. The concrete in foundation shall be watered for atleast 7 days to ensure proper curing.

3.03 Chain Link:

A. The chain link shall be of approved manufacture and of correct size, gauge etc. It shall be of M.S. or G.I. as specified of approved manufacture and of required size, gauge etc. The base materials of the wire shall be of good commercial quality mild steel. The wire shall be circular in section, free from rust, scale, cuts, welds and other defects and shall be uniformly galvanized if specified.

B. Chain link fencing should be of 10 gauge G.I. Wire with 50mm x 50mm square diamond pattern. The chain link fencing shall be fixed between angle framing and M.S flat bedding, bolted with 6mm dia bolts at 300mm c/c on all four edges.

3.04 Fixing of the Chain Link fencing to MS or CC post:

A. The chain link of specified height of fencing shall be fixed first to the end post with necessary G.I. approved type U clamps threaded at both the ends and G.I. nut, bolts, washers etc. and with 6 mm. dia. full height M.S./G.I. anchor bar. After fixing the chain link at the end post, it shall be stretched tightly and fixed to next post one after the other by the above mentioned clamps and bars etc. leaving 50 mm. clearance from the ground and 20 mm. clearance in the case of concrete coping at bottom to avoid rusting. The point at the change in level of the fencing top/bottom, necessary links shall be adjusted suitably as per the manufacturers specification or as directed by the Company Representative. The entire chain link fence shall be painted with two coats of synthetic enamel paint of approved make and shade over a coat of approved primer or as specified in the item/drawing.

3.05 Method of Measurement:

A. The work shall be measured in accordance to IS 1200 and in running metre length of fencing correct to a centimeter for the finished work from centre to centre of the posts.

END OF SECTION 02150.

SECTION 02160 CONCERTINA WIRE FENCING

PART 1 - GENERAL

1.01 Reference:

A. Section 02000 applies to and governs the work of this Section.

1.02 Work Included:

A. The work shall generally be carried out as per these specifications, relevant drawings and as directed by the Engineer.

B. The work of this section includes, but is not necessarily limited to, the provision of all labour, materials, tools and equipment to carry out Construction of site fencing.

1.03 Related Work:

A. Section 02220 - Excavation

B. Division 5 - Metal work

1.04 Alternatives:

A. Not Applicable for this section

1.05 Submittals:

A. Submit drawings in accordance with Section 01007 and AS-BUILT drawings as per Section – 01016

1.06 Codes and Standards:

A. The following are applicable standards established by the Bureau of Indian Standards govern the materials and workmanship of Work under this Section:

1. IS: 278 : Galvanized Steel Barbed Wire for Fencing

B. Where provisions of the pertinent codes and standards conflict with these Specifications, Drawings and Datasheets or with each other, comply with the more stringent provision.

C. Use the latest issue of Standards.

PART 2 - PRODUCTS

2.01 General:

A. Comply with the product requirements outlined in this Section.

B. Select other materials not specifically described but required for the proper completion of the work subject to the approval of the Engineer.

2.02 Materials:

A. M.S. Posts and Struts

All the M.S. posts/struts shall be free from rust, scale, cracks, twists and other defects and shall be fabricated to the required shape and size out of the specified sections. The posts and struts shall be conforming to relevant specifications stipulated here-in-before under relevant sections. All the posts and struts shall be of sizes and lengths as specified in the Tender Schedule and Drawing. The posts and struts shall have split ends for proper fixing and shall be embedded in the cement concrete of mix. M15 or as specified in the schedule. The exposed surfaces of the posts and struts shall be painted with two coats of synthetic enamel paint of approved make and shade over a coat of approved anticorrosive primer.

PART 3 -EXECUTION

3.01 Spacing of the Posts and Struts:

A. The spacing of posts shall be 3 m. centre to centre or otherwise as specified in drawings, to suit the dimensions of the area to be fenced. Every 10th posts, last but one end posts, corner posts, and posts where the level of fencing changes in steps and end post when the fencing changes its direction shall be strutted on both sides, or as directed by the Engineer. End posts where barbed wire fencing is discontinued shall be strutted on one side only.

3.02 Fixing of M.S Struts:

A. Pits of size 45 x 45 x 45 cm. deep or of sizes mentioned in the drawings, shall first be excavated centrally in the direction of proposed fencing work, true to line and level to receive the posts. In case of struts, the pits shall be so excavated, as to receive minimum 15 cm. concrete cover at any point of the struts to suit its inclination or as shown in the drawing.

B. The pits shall be filled with a layer of 15 cm. thick cement concrete of specified mix. The posts and struts shall then be placed in the pits, the posts projecting to the specified height above ground level, true to line, plumb and position, by providing adequate supports temporarily, and cement concrete of specified mix shall then be filled-in so that the posts are embedded in cement concrete blocks of specified sizes. The concrete in foundation shall be watered for atleast 7 days to ensure proper curing.

C. Wherever the posts and struts are to be fixed on brick/block work of compound wall it should be embedded at least 300mm below the top of the wall, with the size 300mm (D) x 300mm(L) x 230mm or thickness of the wall in concrete block of grade M-150 or as specified in drawings.

3.03 Concertina Coils:

A. Concertina barbed tape wire fencing of 600mm height to be provided on top of the compound wall.

B. Specifications of Concertina Barbed Tape Fencing:

Dia of coil - 600

Length of each coil - 9m

No. of spirals per coil - 80

Core Wire:

Dia of core wire - 2.5 +/-0.1mm

Tensile strength of core wire - 1500mPa(160Kg/Sqm)

Galvanising	-	250 to 300 gms zinc per Sqm
Razor Blade:		
Thickness of blade	-	0.6 +/-0.05mm
Length of each blade	-	30mm
Width of each blade	-	20mm including reinforcing flange of 8mm thick
Galvanising	-	160gms zinc per Sqm
Clips		
Material	-	G.I
No. of clips	-	min. 3nos. per coil

C. The concertina fencing shall be supported by min. 3 nos. of reinforced barb tape wire passing through MS angle posts provided on top of the compound wall. The concertina fencing shall be coated with first quality synthetic enamel paint of approved colour.

3.04 Method of Measurement:

A. The work shall be measured in running metre length of fencing correct to a centimeter for the finished work from centre to centre of the posts.

B. The rate shall include the cost of labour and materials involved in all the operations described above including the cost of barbed wire, turn buckle, straining bolts, bolts and the nuts/U clamps including excavation and foundation concrete or as specified in item description for the work.

END OF SECTION 02160.

SECTION 02220 EXCAVATION

PART 1 - GENERAL

1.01 Reference:

A. Section 02000 applies to and governs the work of this Section.

1.02 Work Included:

A. Excavation work required for this Contract includes, but is not necessarily limited to:

1. Excavation for footings, foundations, underground structures and slabs on grade
2. Trenching for interconnecting piping, rising mains, bypasses and electrical conduits
3. Excavation for manholes and miscellaneous chambers
4. Over-excavation to remove unsuitable material
5. Temporary excavation for shoring
6. Excavation for drainage and dewatering
7. Excavation of material from borrow site
8. Disposal of surplus and rejected excavated material and rock
9. Excavation of existing asphalt and concrete
10. Lighting for excavation

1.03 Related Work:

A. The following related work is covered elsewhere in the contract documents:

1.	Section 02720	-	Roads & Paving
2.	Section 02100	-	Site Preparation
3.	Section 02221	-	Backfilling and Filling
4.	Section 02600	-	Rising Main and By-Pass
5.	Division 3	-	Concrete Work
6.	Division 15	-	Pipes
7.	Division 16	-	Electrical

1.04 Alternatives:

A. Not applicable for this Section

1.05 Submittals:

A. Submit excavation plan in accordance with Section 01007

B. Provide laboratory test reports of backfill soil, including sieve analysis, specific gravity, plastic limit and optimum moisture content. Also submit testing schedule to ensure uniformity of material supplied.

1.06 Standards and Codes:

A. The applicable standards established by the Bureau of Indian Standards govern the materials and workmanship employed in the manufacture of all equipment/items.

1.	IS: 3764	-	Safety Code for Excavation Work
2.	IS: 6313 (Part 2)	-	Anti-Termite Measures in Buildings - Pre-Construction Chemical Treatment.

3.	IS: 3385	-	Code of Practice for measurement of Civil Engineering works
4.	IS: 2720	-	Part II - Determination of Moisture Content
		-	Part VII - Determination of Moisture Content Dry Density relation using light compaction
		-	Part VIII - Determination of Moisture Content Dry Density using heavy compaction
		-	Part XXVIII - Determination of Dry Density of soils, in place, by the sand replacement method
		-	Part XXIX - Determination of Dry Density of soils, in place, by the core cutter method.

B. Where provisions of the pertinent codes and standards conflict with these Specifications, Drawings and Datasheets or with each other, comply with the more stringent provisions.

C. Use the latest issue of Standards.

1.07 Classification of Excavated Material:

A. The following general classification of excavated material applies to this Contract:

1. Topsoil - material overlying the silt, clay and silty clay strata. Topsoil contains organic substances.
2. Silt, Clay and Silty Clay - inorganic materials overlain by topsoil.
3. Silty Sand and Gravel - inorganic deposits overlying bedrock formation. May contain boulders large enough to be classified as Rock.
4. Rock - bedrock formation lying in solid horizontal or inclined beds, and boulders measuring 0.40 m^3 or more in volume
5. Other Materials:
   a) Soft or disintegrated rock, which can be loosened by picks or excavating machinery.
   b) Debris such as construction materials, cinders, ashes, garbage, refuse, equipment, trees or tree stumps and other materials unsuitable for foundations.
   c) Miscellaneous inclusions such as asphalt, concrete, bricks, steel, wood, etc.

PART 2 - PRODUCTS

2.01 General:

A. Provide sheeting or sheet-piling and shoring or bracing in open cut to the satisfaction of the Engineer as per Section - 02400.

B. Provide fences or barricades etc as required for safety.

C. The Engineer may order all or any part of the Work to be stopped until an acceptable material is furnished and the condemned material replaced.

PART 3 - EXECUTION

3.01 General:

A. Complete excavations to the necessary depths as shown on the Drawings. Construct slabs and footings on undisturbed ground, unless otherwise required by field conditions or noted on the Drawings.

B. Slope earth banks created by excavating at sufficient angle to prevent sliding or caving in. If necessary to protect adjacent structures, for safety, for dewatering operations, to expedite the work or for other reasons as deemed necessary by the Engineer, supply and install caissons, cofferdams, sheet-piling, underpinning, well points and/or pumps to the satisfaction of the Engineer.

C. Provide, and maintain necessary fences and barricades before and during excavation work.

D. Remove water and material of any nature from the excavations that could interfere with construction work and safety.

E. Where the bearing value of the subgrade is determined by the Engineer to be unsuitable, over-excavate to the depths as directed by the Engineer.

3.02 Trench Excavation:

A. General:

1. Be responsible for maintaining the stability of the excavations by employing suitable construction methods including, but not limited to, sheeting, shoring, and dewatering.
2. Excavate for utilities by open trench unless otherwise specified or shown on the Drawings.
3. Contractor shall provide sufficient number of wardens to maintain smooth flow of traffic during execution of work for pipeline
4. No separate payment will be made for dewatering in trenches/excavation
5. Barricading shall be done as per the circular no.MGC/F/6342 dated 05.05.2018 or any revision thereof.

B. Maximum Length of Open Trench:

1. Except by permission of the Engineer, ensure that the maximum length of open trench is 30 metres or the distance necessary to accommodate the length of pipe installed in a single day, whichever is the greater. The distance is the collective length at any location and includes open excavation, pipe length and appurtenant construction and backfill that have not been completed.

C. Maximum and Minimum Width of Trench:

1. Unless otherwise shown on the Drawings or approved by the Engineer, ensure that the minimum and maximum width of pipe trench (except for corrugated metal pipe) permitted at the height of 300 mm above the top of the pipe is as follows:

a) Minimum trench width for a single pipe:

i. For pipes with inside diameter of 900 mm or less: allow 300 mm on each side of the outside diameter of the pipe or 760 mm, whichever is greater, plus allowance for any shoring.

ii. For pipes with inside diameter larger than 900 mm: allow 500 mm on each side of the outside diameter of the pipe, plus allowance for any shoring.

b) Minimum trench width where multiple pipes are laid side by side: 300 mm between the trench wall and the edge of the pipe, closest to the trench wall, on both sides of the trench or 1000 mm, whichever is greater, plus allowance for any shoring. Allow a minimum distance of 300 mm between adjacent pipe walls.

c) Maximum trench width, including an allowance for shoring: 700 mm greater than the minimum width specified above, for pipes 450 mm diameter and larger; and 400 mm greater than the minimum width specified above for pipes 400 mm diameter and smaller.

2. If the maximum trench width, as measured at 300 mm above the top of the pipe, is exceeded, provide additional bedding, another type of bedding or a higher strength of pipe.

D. Depth of Trenches:

1. Excavate trenches to provide a uniform and even surface at the depth and in the shapes required for the foundations of the pipes, appurtenances and their bedding as shown on the Drawings and as specified. If the trench is excavated below the required level, fill the excavation to the correct level with approved fill, concrete or other approved material to the satisfaction of the Engineer.
2. Where, in the opinion of the Engineer, the soil at the bottom of the excavation does not afford a satisfactory foundation after dewatering as specified has been carried out, excavate the trench to such increased depth as the Engineer may direct and bring the bottom of the trench to the required level with an approved material to the satisfaction of the Engineer.

3.03 Lighting for Excavation:

A. In public areas, provide sufficient lighting at night for excavations, trenches, obstructions, materials etc taken, kept or deposited in connection with the work, in order to guard against any damage or danger to traffic. Take all precautions to keep all the lamps lit for the whole night for the guidance of traffic in the following manner:-

1. All lamps must be kept at a height of 1m to 1.25m.
2. Provide red lamps at the corners of excavations. Provide white or yellow lamps in other locations.
3. If the intermediate space happens to be at a junction of roads, use red lamps.
4. Space lamps across the direction of traffic at a distance of not more than 2.0 m apart.
5. Space lamps along the line of traffic at not more than 15m apart.
6. In case of a small excavation or pot-hole, place a barrel over the excavation or over the excavated portion with a red lamp on it.
7. To take such other measures as may be directed by the Engineer from time to time for the safety of traffic.

B. Excavations and other works in public areas shall be properly fenced to prevent inadvertent access.

3.04 Excavation for Structures:

A. Excavate for footings, foundations and basement walls, floor pits and other subsurface construction making due allowance for construction of formwork, bracing, shoring and supports and pumping and drainage systems.

B. Remove from the excavation material that the Engineer deems unsuitable for foundations, including material that sloughs off the sides of the excavation. Maintain the bottom of the excavation firm and dry and acceptable to the Engineer.

C. Except where over excavation is specified (eg for removing unsuitable material), ensure that machine excavation for base slabs and footings does not extend closer than 50 mm to the finished sub grade. Trim the finished subgrade evenly and remove loose materials.

D. Fill voids between the limits of excavation and the neat lines of the underside of structures with fill concrete, except where otherwise specified. Be responsible for excavations that exceed the limits authorized by the Engineer.

E. Where the bearing value of the sub grade is determined by the Engineer to be unsuitable, excavate to the depth directed by the Engineer.

3.05 Protection of Structures and Utilities:

A. Take the necessary precautions to protect existing or newly constructed works. If undermining should occur, correct the undermining by breaking out and repairing the existing structure and/or replacing the disturbed foundation material with fill concrete, grout, sand, etc as may be directed by the Engineer. This applies also to electrical cables, piping and appurtenances already constructed in the area, whether above or below ground or which appear within the trench.

B. In case of damage of any kind, including settlement or lateral movement of adjacent structures, utilities or surface features as a result of the Work, immediately rectify such conditions and any resultant damage to the satisfaction of the Engineer.

3.06 Dewatering of Excavations:

A. Refer to Section - 02530 - Dewatering.

3.07 Stockpiling and Disposal of Excavated Materials:

A. Stockpiling:

1. Separate excavated materials into the following groups:
    a) Approved topsoil
    b) Approved silt-clay or sand-gravel materials
    c) Approved fill
    d) Rejected topsoil and rejected silt-clay or fill materials
    e) Rock
    f) Other material
2. Stockpile excavated materials separately in locations within the construction site to the approval of the Engineer.
3. Material excavated from trenches may be stockpiled beside the trench within the provisions herein set out. Deposit excavated material on one side of the trench only, unless otherwise directed. Remove, dump, spread and re-grade any excess material remaining after backfilling of trenches as directed by the Engineer.

4. Do not stockpile excavated material immediately adjacent to trenches if a safety hazard is created.
5. Control the stockpiling of material removed from trenches in such a manner that prevents water from flowing into the excavation.
6. Do not obstruct surface drainage. Provide means whereby storm and waste waters are diverted into existing gutters, other surface drains, or temporary drains.
7. Stockpile contaminated soils and suspected contaminated soils separately from the soils to be re-used for backfill as directed by the Engineer. Stockpile contaminated soils on ground sheets and cover with tarpaulins as directed by the Engineer.
8. Rock/soil excavated shall be stacked properly as directed by the engineer. As a rule, all softer material shall be laid along the Centre of the heaps, the harder and more weather resisting materials forming the casing on the sides and the top. Excavated soft rock or hard rock shall be stacked separately.

B. Disposal:

1. Dispose off site, waste rock, rejected excavated material and surplus excavated material that will not be required for be used in backfilling, spreading, repairing and restoration, except as noted otherwise in the Contract Documents, to the satisfaction of the Engineer.
2. The Engineer shall determine what material is suitable or unsuitable for re-use.
3. Dispose of rejected or contaminated soils off-site at properly licensed facilities in conformance with applicable regulations.
4. Any spills or deposits on public roads and other areas shall be promptly cleaned up.

3.08 Soil Investigations:

A. Where soil tests have been carried out, the soil boring logs are shown on the relevant drawings for guidance only.

B. The Contractor is explicitly warned that that the number of tests carried out are limited and any inferences drawn from the logs shown on the Drawings and the preserved samples together with any extension of the results obtained from one or more tests at any site to the entire site shall be deemed to be based on his own judgment and at his own risk.

3.09 Utilities Protection

A. All utility lines and structures not dealt with in Section 02100, whether indicated on the Drawings or not, which remain in service shall be protected by the Contractor from any damage likely to result from his operations.

B. Where damage is likely to result from his operations, a utility shall be relocated with the approval of the Engineer and the utility authority. If any utilities not shown on the Drawings are encountered, the Contractor shall immediately convey the information to the Engineer before proceeding further. Any damage to any utility resulting from the Contractor's operations shall be repaired at the Contractor's expense.

3.10 Joint Building Survey

A. Prior to the start of construction, carry out a joint survey of the conditions of the structures together with the Engineer and the occupiers of the structures or their authorised Engineer to prevent any dispute regarding the extent of damage and / or deterioration of the structures.

B. Carry out a joint survey of the same premises during the course of construction, to keep a vigil on the structures and observe the effect of site operations.

C. Make good any damage or deterioration of the structures caused by construction operations.

D. Carry out a final joint survey of the premises on the completion of the work. Any damage and/or deterioration of the structures or any elements of the same shall be made good by the Contractor. The Contractor shall indemnify and save the Corporation harmless from any claims, expenses etc arising out of the execution of the contracted work.

E. The survey shall be a detailed survey of each and every premises in the vicinity of the work site and shall include mapping of existing cracks, crevices, deterioration and deformation of individual structures.

3.11 Excavation in Rock:

A. This includes material which is required to be excavated by use of pick axes, crow bars or by chiseling or by wedging or any other rock quarrying method including using pneumatic or hydraulic tools or breakers including hydraulic splitters. Blasting is not permitted.

3.12 Removing Surplus Excavated Material:

A. Surplus soil, stones, boulders and other materials shall be removed from site.

B. Surplus excavated material shall be cleared from public roads immediately so that the public are not inconvenienced in any way.

C. Boulders and rocks got during excavation shall be properly tested for their properties in laboratories. The report for the same shall be submitted to BMC and after clearance from BMC the boulders and rock shall be disposed off from the site.

3.13 Anti Termite Treatment

A. Refer Section 02810.

END OF SECTION 02220.

SECTION 02221 BACKFILLING AND FILLING

PART 1 -GENERAL

1.01 Reference:

A. Section 02000 applies to and governs the work of this Section.

1.02 Work Included:

A. The backfilling and filling work includes, but is not necessarily limited to:

1. Backfilling for structures and filling to attain the grades indicated on the Drawings;
2. Backfill of demolished areas/structures;
3. Trench backfilling;
4. Rough and finish grading.

1.03 Related Work:

A.	Section 02220	-	Excavation
B.	Section 02400	-	Sheeting, Shoring and Bracing
C.	Section 02480	-	Landscaping
D.	Section 02720	-	Roads and Paving
E.	Section 02600	-	Rising Main and Bypass
F.	Division 15	-	Piping
G.	Division 16	-	Electrical

1.04 Alternatives:

A. Not Applicable for this section

1.05 Submittals:

A. Contractor proposes to use on site soils fill or backfill, have the soils tested for conformity to these specifications. Submit test results to the Engineer.

1.06 Codes and Standards:

A. The following are applicable standards established by the Bureau of Indian Standards govern the materials and workmanship of Work under this Section:

1. IS: 3764 : Safety code for Excavation Work
2. IS: 2720 : Part II - Determination of Moisture Content
   : Part VII - Determination of Moisture Content Dry Density relation using light compaction
   : Part VIII - Determination of Moisture Content Dry Density using heavy compaction.

B. Where provisions of the pertinent codes and standards conflict with these Specifications, Drawings and Datasheets or with each other, comply with the more stringent provision.

C. Use the latest issue of Standards.

PART 2 –– PRODUCTS

2.01 General:

A. Ensure that fill material is free of rubbish, roots, wires, cans or debris of any sort including deleterious material. Boulders, rock or concrete fragments over 100 mm in size are not suitable backfill material. The fill material is subject to the approval of the Engineer.

2.02 Materials:

A. Approved fill: to consist of suitable soil or granular material that has been removed from the excavated areas, designated borrow areas, or that has been hauled from an approved off-site source. Ensure that this material is acceptably dry, free from roots, large stones, boulders or large broken rocks, refuse, vegetable matter, topsoil, silt or debris.

B. Approved Granular Fill: suitable granular material meeting the requirements of the standard specification and with a maximum stone size of 100 mm.

C. Other Materials: select all other materials, not specifically described but required for proper completion of the work of this Section, subject to the approval of the Engineer.

PART 3 - EXECUTION

3.01 General:

A. No foundation shall be permitted on backfilled soil. Wherever such foundation on backfill is unavoidable, the contractor shall obtain specific permission of the Engineer and carry out the work strictly according to his instructions

B. Place materials that are to be compacted in layers not thicker than 300 mm, loose depth, and of the proper moisture content before compacting, to facilitate obtaining the prescribed compaction.

C. Remove temporary planking, formwork etc as backfilling progresses to avoid formation of voids.

D. Ensure that excavated foundations are inspected and approved by the Engineer before proceeding with further work, including placing of skim coat, bedding, reinforcement steel etc.

E. Make grades and lines as indicated on the Drawings. The Engineer reserves the right to make minor adjustments to the lines and grades or revisions where necessary, to correct any discrepancy, accommodate piping runs, etc.

F. Slope areas to avoid pooling of water.

G. Repair damage and correct deficiencies that may result from the settlement of backfilled areas.

3.02 Foundation Bedding:

A. Unless otherwise specified, construct new concrete foundation floors and base slabs on the bedding as shown on the Drawings.

B. Compact the bedding material, except for clear crushed stone, by mechanical means at optimum moisture content to value of 98% Standard Proctor Maximum Dry Density (SPD) .

C. Where indicated on the Drawings, install perforated under drains with risers and flap gates in granular trenches, below the foundation bedding.

D. If required, backfilling may have to be carried out with local sand, the sand used shall be clean, sharp, angular, hard and durable, free of clay, mica and soft flaky pieces and free from other impurities. Sea sand shall not be used. All sands must be well washed and cleaned before use. Medium grain sand shall be used.

E. Sand shall be kept flooded with water for 24 hours to ensure maximum consolidation. Any temporary work required to contain sand under flooded condition shall be to the Contractor's account. The surface of the consolidated sand shall be dressed to the required level or slope. Construction of floors or other structures on sand fill shall not be started until the Engineer has approved the fill.

F. Prior to placing of any foundation, the Contractor must carry out in-situ plate load test to demonstrate that the soil bearing capacity exceeds the value prescribed in the drawings to the satisfaction of the Engineer.

G. Dry Rubble Stone Packing for Foundation-

1. Rubble used for packing under floors, foundations etc shall be hard and durable rock, free from veins, flaws and other defects. The quality and size of the rubble shall be subject to the approval of the Engineer.

2. Rubble shall be hand packed as directed by the Engineer. They shall be laid closely in position on the sub-grade. All interstices between the stones shall be wedged in with smaller stones of suitable size, well driven to ensure tight packing and complete filling of interstices. Such filling shall be carried out simultaneously with the placing in position of rubble stones and shall not lag behind.

3. Interstices shall be filled with small stone chips and hard clean sand and well watered and rammed.

3.03 Backfilling against Walls:

A. Unless otherwise specified on the Drawings or approved by the Engineer, ensure that the period of time after which the Contractor may place backfill against or on top of any cast-in-place structures is greater than or equal to the time periods as shown in the table below:

Operation	**Location**	
	Against Sides of Structures	On Top of Structures
Placement of Loose Backfill	5 days	21 days
Compaction of Backfill	7 days	28 days

B. Observe any special backfilling requirements or materials, such as those for sub-drain and perimeter drain filters and insulation/expansion material where specified and/or shown on the Drawings.

C. Use approved granular fill, as specified, as backfill around the walls of the structures, to the extent as shown on the Drawings. Place the fill in maximum 150 mm layers loose depth and compact by mechanical means to a value of 100% SPD, unless otherwise indicated on the Drawings. Do not use heavy compaction equipment within 3 m of new walls. To achieve the specified degree of compaction, bring the moisture content of the material up to the optimum level and ensure that the moisture content does not exceed this optimum by more than 2%. Bring the backfill up to within 600 mm of finished grade elevation. For the remaining fill, use approved fill and topsoil, as required for site grading, unless otherwise specified. Place backfilling in road and paving areas to within 750 mm of the surface and then complete using road construction materials as specified.

D. Where walls are waterproofed on the exterior, or where expansion material has been placed, place backfill by hand against walls to prevent damage to the waterproofing membrane. Should any damage to waterproofing occur, re-excavate such areas and repair the membrane or coatings to the satisfaction of the Engineer.

E. Where fill is required on both sides of a wall, foundation or culvert, deposit it layer for layer at each side, alternately.

3.04 Backfilling of Piping and Electrical Conduit Trenches:

A. Proceed with backfilling of pipe and conduit trenches as specified in the Drawings, as soon as practicable. Do not backfill pipe that is to be tested, except for bracing purposes, until testing has been completed to the satisfaction of the Engineer. Where concrete thrust blocks are used, allow sufficient time for the concrete to obtain adequate strength before testing and backfill.

B. Backfill starts at the top of the bedding above the pipe or conduit. All materials below this elevation are considered as bedding. Refer to Section 02600.

C. Backfill for cast-in-place piping, appurtenances or structures such as manholes starts at the subgrade for the structure. Ensure that the backfill is brought up simultaneously and equally on all sides of the structure.

D. Exercise care during backfill operations to prevent damage or dislodging of pipe and conduit. Should any damage occur, correct damage or dislodging of pipe or conduit to the satisfaction of the Engineer.

E. Backfill trenches in the general site area (except in road, parking and walkway areas) using approved fill to the underside of the topsoil or finished grade as required in layers not exceeding 300 mm in loose depth. Compact in layers to 98% SPD.

F. Backfill buried electrical conduit and other utilities as indicated on the Drawings and similar to that specified for piping.

G. Where it has become necessary to excavate beyond the limits of normal excavation lines to remove previously unknown boulders or other interfering objects, backfill the remaining voids to the approval of the Engineer.

3.05 Roads and Paved Areas:

A. Refer to Section 02720

B. Bring the backfill in areas under roads and paved areas to the underside of the sub-base using approved granular fill. Compact in layers of 150 mm to 98% SPD. In areas adjacent to structures, thinner layers may be required to suit lighter compaction equipment.

C. In road cut sections, excavate unsuitable material (silt, humus, topsoil etc) and replace it to the level of the sub-base with approved granular fill. Ensure that the minimum excavation in cut sections extends to the depth of the road base as shown on the Drawings. Where directed by the Engineer, due to excessive thickness of unsuitable material, over-excavate in cut sections to a maximum depth of 900 mm or as otherwise directed.

3.06 Site Grading:

A. General:

1. Grade the site to the elevations indicated on the Drawings with due allowance for topsoil and turfing, or as directed by the Engineer. Ensure that the ground slopes away from structures in the immediate vicinity of structures.
2. Have the site grading approved by the Engineer before proceeding with landscaping. Provide drainage to an outlet point without ponding.
3. Place fill for site grading in 300 mm layers and compact to a value of 98% SPD.

B. Additional Fill for Site Grading:

1. Supply necessary additional fill material that may be required to raise the new site grades above the existing grades, as indicated on the Drawings.
2. Procure additional material required from the borrow site or other approved source and deliver to the site. Use approved fill as specified.

C. Ditches and Swales:

1. Trim, grade and slope ditches (normal trench) and swales (low tract of land when moist or marshy) as shown on the Drawings, to the satisfaction of the Engineer.

3.07 Settlement Repairs:

A. During the specified period of maintenance, make good damage to walkways, roads, turfed areas etc due to settlement of backfilled areas upon notification by the Engineer.

B. Should the Contractor fail to carry out any necessary remedial work within two working days after receiving written instruction from the Engineer, the BMC may carry out the work and deduct the cost incurred from payments to the Contractor.

3.08 Compaction

A. The compaction of backfill shall be a controlled operation using the optimum moisture content as determined by the soil test reports and achieved where necessary by the addition or removal of water, followed by adequate mixing to ensure uniform moisture content. The dry density achieved shall not be less than 95% of the maximum dry density as determined by the Standard Proctor Test as per IS 2720 (Part VII) or a higher value if one is specified in particular circumstances.

B. Specification for compaction of fill in embankments constructed for particular functions are shown on the drawings.

END OF SECTION 02221.

SECTION 02400 SHEETING, SHORING AND BRACING

PART 1 - GENERAL

1.01 Reference:

A. Section 02000 applies to and governs the work of this Section.

1.02 Work Included:

A. The provision of all materials, labour, tools and equipment necessary and all work done on and off the site to provide in a satisfactory, effective and workmanlike manner, all necessary sheeting, shoring and bracing indicated, required or ordered by the Engineer

B. Supply and install piling, diaphragm walls, bracing, shoring and dewatering systems (specified in section 02530) to adequately protect existing buildings and facilities and to maintain excavation required for the construction of facilities.

C. Responsible for the adequacy of the piling, diaphragm walls, bracing, shoring and dewatering of the site to maintain safety and prevent damage to existing buildings, facilities, excavation, and new construction. The configuration of the proposed shoring and bracing shall be reviewed by the Engineer. Such approval shall however signify only the acceptance of the methods proposed and the responsibility for their structural adequacy and the degree of safety provided shall remain with the Contractor.

1.03 Related Work:

A. Section 02200 - Excavation

B. Section 02221 - Backfilling

C. Section 02530 - Dewatering

D. Section 02600 - Rising Main

E. Division - 15

F. Division - 16

1.04 Alternatives:

A. Not Applicable for this section

1.05 Submittals:

A. Contractor shall submit to the Engineer a detailed construction procedure prior to commencement of work, along with the drawings of the proposed shoring, strutting and bracing.

B. Submit to the Engineer, every four weeks, a signed and sealed construction report detailing the load tests and changes/remedial work to shoring/piles.

1.06 Codes and Standards:

A. The following applicable standards established by the Bureau of Indian Standards govern the materials and workmanship of work under this Section:

1. IS 3764 - Safety code for Excavation Work
2. IS 1641 and 1642 - Fire Safety of Building Code of Practice
3. National Building Code – Latest revision

B. Where provisions of the pertinent codes and standards conflict with these Specifications, Drawings and Datasheets or with each other, comply with the more stringent provision.

C. Use the latest issue of Standards.

1.07 Quality Assurance:

A. Employ appropriately experienced personnel to direct field work.

B. Retain a professional engineer responsible for the shoring/sheet pile design to review the installation, maintenance and removal of the shoring/piles and provide a report to the Engineer on the findings.

1.08 Existing Conditions:

A. Boring logs of soil tests if provided ,it is in good faith and are reasonably indicative of the conditions existing at the site of the tests.

B. Any conclusions drawn from the soil test reports however, shall be the responsibility of the Contractor.

C. Contractor shall be afforded the opportunity to inspect indexed samples preserved by the Engineer.

D. Ensure that all excavations exceeding 0.6m depth are supported or excavated with stable side slopes. Where conditions which are inconsistent with the safety of personnel required to work within the excavated area are encountered, such excavation shall be sheeted or shored as required to provide adequate safety.

E. If the Contractor fails to provide safety measures, the Engineer shall order the Contractor to provide same within the terms of the Contract, at no extra cost to the BMC.

F. Damage to new or existing structures or utilities in place arising out of inadequate protection shall be repaired at the Contractor's expense and to the approval of the Engineer.

G. The Contractor's attention is specially drawn to the necessity for a thorough study of the site and soil conditions, groundwater levels and other relevant factors, particularly in the case of the wet wells, incoming sewer connections and force mains before deciding on the necessity or otherwise of sheeting, shoring and bracing and if provided, the adequacy of same.

H. The Contractor shall locate existing facilities in service, if any, and avoid sections that may interfere with driving sheeting. If such avoidance is not possible, the Contractor shall relocate the facility as required to clear the interference. Any action proposed in such circumstances shall have the prior approval of the Engineer.

I. Excavations shall be dewatered to the satisfaction of the Engineer in accordance with the requirements of Section 02530.

J. Take photographs and notes on the condition of the excavation before and after the shoring. Submit two sets of these records to the Engineer.

1.09 Design Parameters:

A. Design systems based on recognized geotechnical and structural theories and principles for all applicable lateral pressures from soil and groundwater, including unsymmetrical surcharge loads from construction operations. Coordinate the design of the sheet piling system with the design of the dewatering system.

B. Ensure that bracing is fully effective at all stages of construction. Pre-stress bracing, if required, to control deflection to limits specified.

C. Design temporary supports for existing structures and/or utilities to safely resist all loads including construction operations.

1.10 Performance Requirements:

A. Construct a sufficiently watertight system suitable for the geotechnical conditions encountered.

B. Prevent destabilization of sub-grade, displacement and/or settlement of existing structures/foundations, or damage to any structure and/or works.

C. Prevent disturbance, displacement or damage, to sides and bottom of excavation, to new and existing structures, pipelines, utilities, roads, embankments, etc at any stage of construction of the works.

PART 2 - PRODUCTS

2.01 Steel Pilling and Shoring Materials:

A. Steel sheet piles shall conform to the requirements of IS 2314 and the steel for walls, struts braces and tie rods shall comply with IS 226. Any materials subsequently to be incorporated into the permanent works shall be new.

B. Piles shall be of the types and sizes indicated in the approved shop drawings and shall be of a design that provides continuous interlocking throughout their entire lengths.

C. Standard handling holes shall be provided located approximately 100 mm below the top of each pile unless otherwise specified. All nuts, bolts, high-strength bolts, rivets and welding shall comply with the relevant Indian Standards.

D. The minimum compressive strength of concrete in contiguous caisson walls: 20 MPa at 28 days.

E. Reinforcement to comply with IS 432 – 1982, IS 1786 – 1985.

2.02 Timber Shoring:

A. If the Contractor elects to use timber shoring for trench and structure excavations he shall provide details of the shoring he proposes to adopt, taking into consideration the nature and condition of the soil to be excavated and the depths to which the excavations are to be carried.

B. The quality and strength of the timber and the cross-sectional details and spacing of the shoring, walling and struts together with the calculations, where required or demanded by the Engineer, demonstrating the structural adequacy of the proposed shoring and timbering shall be included in the submittals.

C. Tie-back anchors are to be provided as required.

D. Select other materials not specifically described but required for the proper completion of the work under this Section.

PART 3 - EXECUTION

3.01 General:

A. Piling shall be accurately located and driven to the required depths.

B. Ensure that piles are plumb and true to line with each pile interlocking with the adjacent pile throughout its entire length.

C. Frames, temporary walls templates, guide-frame and bracing as are necessary shall be installed to guide and support the sheet piling in correct position and alignment.

D. The choice of specific construction procedure appropriate for any works or phase thereof shall be the Contractor's responsibility.

E. The procedure adopted shall meet the requirement of the works and specific procedures adopted such as construction methods, shoring, sheet piling, bracing, dewatering etc. are at the option of the Contractor.

F. Be responsible for all setting out with reference to the site survey.

G. Be responsible for repairs to the adjacent properties as a result of damage caused by the installation of caissons, shoring, etc.

H. Install piles and lagging in accordance with the submitted layout and detail drawings and as directed by the engineer responsible for the shoring design. Ensure that soldier piles are continuous to the top of the excavation.

I. Ensure that the construction procedure detailed on the drawings determines the sequence of construction.

J. Ensure that splices in walers develop the full strength of the member in bending, shear and axial compression. Furnish walers with openings in web to suit diameter, as well as 25 mm diameter air relief holes at 600 mm. If bracing members such as walers etc are to be removed during construction, ensure that the timing and procedure of removal do not induce stresses in permanent structures or in steel sheet piling or bracing members in excess of those allowed by applicable codes.

K. Consolidate or remove loose material at the bottom of holes for soldier piles.

L. Use steel liners or bentonite slurry to prevent cave-ins during the installation of caissons.

M. Ensure that there are no cavities behind underpinnings.

N. Withdraw all temporary cribbing subjected to rot or deterioration before placing of the backfill.

3.02 Driving:

A. Piling shall be driven by approved methods in such manner as not to subject the piles to damage and to ensure interlocking throughout the length of each pile.

B. Pile hammers shall be of the size and type needed to achieve the required penetration with the minimum damage to the piles.

C. Hammers shall be maintained in proper alignment with the piles during driving by use of suitable leads or guides. A protective driving cap of approved design shall be used, as required, to minimize damage to tops of piles.

D. Unless with the Engineer's approval, pile driving shall be done without jetting.

E. The piles shall be driven plumb and if the sheet piling goes progressively out of plumb, corrective steps shall be taken. If necessary, they shall be withdrawn and re-driven so that no part of any pile is more than 75 mm from the design location of the bulkhead alignment on completion of the work.

F. Piling shall be driven in stages. No sheet pile, or pair of piles if driven in pairs, shall be driven more than one-third its length before the adjacent sheet pile is set.

G. Replace piling that is damaged. Withdraw piling driven more than one third its length before the adjacent sheet pile is set. Piling that is damaged or driven without interlocking shall be withdrawn and re-placed.

H. The Engineer is empowered to order withdrawal if he has reasonable grounds to suspect damage. Any encroachment of piles upon plain concrete piles shall be sufficient grounds for withdrawal and replacement.

I. If obstructions are encountered during driving, the piles in question shall be driven at least to the specified refusal driving resistance after adjacent piles have been set and driven. However, the number of sheet piles permitted to be driven short of the required depths shall be limited in the field by the Engineer, and if so directed, the Contractor shall remove obstructions encountered by whatever means found necessary, at no extra expense.

J. Splices shall be avoided if practicable, but where unavoidable shall be designed to develop the full strength of the piling.

K. Detailed drawings of the proposed splices shall be approved prior to execution, extreme care shall be exercised to align the spliced sections so that the axis of the pile will be straight and that the interlocks of the piles shall form a straight, smooth and continuous groove.

3.03 Driving Resistance

A. Steam, air or diesel hammers shall be provided with a rated energy not less than the hammer manufacturer's recommendation for the total weight of pile and the type of subsurface material to be encountered. The Engineer may require the Contractor to change the hammer in use to obtain the required minimum penetration.

B. Piling shall be driven to the specified depths as per the approved Shop Drawings to such depth as may be required to provide the degree of protection needed.

3.04 Pre-stressing Tie Rods

A. All tie rods shall be pre-stressed to minimum of 10 percent of their design load. The Contractor shall submit to the Engineer for his approval the proposed procedure for pre-stressing tie rods.

3.05 Site Drainage

A. If required the Contractor shall provide a drainage trench around the sheeting to carry away water collected therein.

3.06 Maintenance:

A. Maintain temporary shoring, sheet piles etc until no longer required.

B. Protect soil behind shoring, sheet piles etc from collapses.

C. Monitor shoring, sheet piles etc so that movement in any direction does not exceed 15 mm. If excessive movement occurs, carry out remedial work required to prevent further movement as directed by the Engineer at no additional cost to the BMC.

3.07 Removal:

A. Remove temporary shoring, sheet piles etc when no longer required and permanent structures can support the design loads. Make good walls and slabs at the penetrations to match adjacent work.

B. Remove caisson walls, soldier piles and lagging a minimum of 1.2 m below the final grade elevation, as soon as the permanent structures can support the design loads.

3.08 Records:

A. Maintain accurate records of the design, construction and monitoring of the temporary shoring, sheet piles etc. Ensure that progress records are made available for review at the work site. Submit two copies of records to the Engineer at the end of the project.

B. The records for each soldier pile to include data on pile size, location and bottom elevation; splice details and location; any deviation and in what direction; and augured hole diameter and bottom elevation.

C. The records for each tie back anchor to include data on the size, anchor length, location, free length, maximum applied load, creep or failure under applied load and lock off load.

D. The records for the shoring to include data on design, location and bottom elevation; any deviation and in what direction; and remedial work (if any).

3.09 Monitoring:

A. Locate soldier piles from a reference line and accurately measure the vertical and lateral movements at the top and lower stress points of the piles to monitor the structural behaviour of the shoring system at the following times:

1. Prior to excavation.
2. Prior to installation of tie backs.
3. One day after stressing the tie backs.
4. At completion of the excavation.
5. At two week intervals following the completion of the excavation.

3.10 Tie-Back Anchor Load Test:

A. Before installing the tie-backs, install a special test tie-back with 33% less anchorage length or 50% stronger tendon and load test the anchor zone to twice the design bond stress. Apply load in six equal increments and maintain full test load for 12 hours before reducing to the working load. Record pile movements, tie-back elongation and creep loss for each increment of load and the creep during the 12 hours following full test load. The tested anchorages are considered adequate if they can maintain the test load without significant creep loss over 12 hours.

B. Properly calibrate jacks for preloading at the start of the work and at regular intervals to the satisfaction of the Engineer.

C. Proof load all tie-backs to 1.33 times the working load and hold for 15 minutes before reducing to working load and lock off. Notify the Engineer if a tie-back fails to hold the proof load or it creeps excessively.

D. Fill in remaining voids in the soil surrounding the anchor with grout after successfully preloading the tie-backs.

E. Promptly submit to the Engineer, the test results complete with the signature and seal of the licensed professional engineer responsible for the shoring design.

END OF SECTION 02400.

SECTION 02480 LANDSCAPING

PART 1 - GENERAL

1.01 Reference:

A. Section 02000 applies to and governs the work of this Section.

1.02 Work Included:

A. Landscaping includes, but is not necessarily limited to:

1. Fine grading and preparing sub-base to the elevations.
2. Supply and placement of topsoil and fertilizer.
3. Supply and application of seed.
4. Supply and planting of trees as specified herein or as required in the locations.
5. Removal, preservation (during construction period) and re-planting of any existing trees, shrubs and other plants, affected by the proposed work. The new location to be determined after final grading is completed.

B. Areas to be seeded:

1. Areas designated on the Drawings.
2. Areas outside of the specified work area disturbed by construction or regraded are to be seeded to the extent as decided by the Engineer.

1.03 Related Work:

A. The following related work is covered elsewhere in the Contract Documents.

1. Section 02220 - Excavation
2. Section 02100 - Site Clearing and Grading
3. Section 02221 - Backfilling

1.04 Alternatives:

A. Not Applicable for this section

1.05 Submittals:

A. Not Applicable for this section

1.06 Codes and Standards:

A. Not Applicable for this section.

1.07 Guarantee:

A. The Contractor shall be responsible for maintaining the landscaping and planting for the duration of the O&M period.

B. Following the O&M period, the BMC will take over the landscaping works except that the Contractor shall replace any planting which is not in a healthy growing condition for the duration of the defects liability period.

C. Damage resulting from acts of vandalism is excluded from the guarantee.

PART 2 - PRODUCTS

2.01 Topsoil:

A. As far as practicable, topsoil shall be obtained from material generated from topsoil stripping in accordance with Section 02100 and separately stored in temporary spoil tips to the satisfaction of the Engineer. If, in the Engineer's opinion, the Contractor cannot reasonably obtain sufficient topsoil of acceptable quality in this way, the Contractor shall, if so directed by the Engineer, provide extra material from an approved off-site source.

B. Preserve the top 6 to 8 inches fertile soil from the constructed area of the site and reuse such soil within the site (or) outside the site premises for landscaping.

2.02 Seeding:

A. Areas which have been covered with 300mm of topsoil shall be sown with an approved species of grass seed suitable for local conditions to the approval of the Engineer,

B. The rate of seed application for the Standard Roadside Mix seed is 1 kg/100 m^2.

C. Water: potable and free of impurities that would inhibit germination.

D. The Contractor shall be responsible for maintaining grassed areas in good condition until the end of the Operation and Maintenance Period including all watering, rolling, fertilizing, weeding, cutting and re-sowing as necessary.

2.03 Fertilizer:

A. Apply fertilizer to the seeded areas and plantings at a rate and frequency as required to maintain healthy growth to the satisfaction of the Engineer.

B. Fertilizer: complete, commercial fertilizer of approved manufacture and granular form, dry, free flowing and free from lumps.

C. Ensure that fertilizers are clearly marked with the name of the manufacturer, contents, weight, and analysis.

D. Store fertilizers in a weatherproof storage place and in such a manner that they will stay dry and their effectiveness will not be impaired.

2.04 Tree Planting List:

A. Plant trees in the locations shown on the Drawings during landscaping work.

B. Trees shall be of a native species.

C. When trees are removed to facilitate construction and later replaced, select trees of the similar size to those removed.

D. The number and type of tree and shrub planting shall be as shown on the drawings.

PART 3 - EXECUTION

3.01 Preparation of Existing Grade:

A. Examine the prepared sub-grade and eliminate local depressions, ruts, ridges, lumps, rock exposures, debris, sub-soil contaminated with oil or petrol etc so that a positively drained visually smooth surface is created. Obtain the approval of the sub-grade from the Engineer prior to commencement of spreading of topsoil.

B. Verify that grades are correct. If discrepancies occur, notify the Engineer and do not commence work until instructed.

C. Remove stones, sticks, sub-soil lumps, or other debris in excess of 50 mm diameter, and surface litter and live weeds from the topsoil and dispose of off-site.

D. Compact sub-grade to 95% Standard Proctor Density.

E. Scarify the sub-grade to a depth of 50 mm.

3.02 Landscaping:

A. Work shall include the laying-out and stocking of flower beds and rockeries, planting of trees and shrubs and for the turfing of lawns.

B. Post –development, provide landscaping (vertical & horizontal), landscaped area being at least 20% of the site area (5% in addition to natural topography)

C. Landscape Species: Select drought tolerant/native/adaptive species by design for at least 20% of landscape area, which will result in reducing substantial water requirement.

3.03 Topsoiling:

A. Topsoil shall be evenly spread and trimmed over embankments/earthwork and other areas to the slopes and grades shown on the drawings. The depth after spreading and trimming shall be 300mm, measured perpendicular to the surface. All clods and lumps shall be broken up and any rubbish, large stones, roots and weeds shall be removed.

B. After the completion of the earthwork, cover with topsoil and sow with grass seed, all as specified hereafter.

3.04 Preparation of Surfaces for Seeding:

A. Examine the condition of the fine-graded and top-soiled slope prior to commencement of the work.

B. Obtain the Engineer's approval of topsoil grade and depth before starting seeding.

C. Ten days after application of herbicide, cultivate soil to a depth of 25 mm (shallow tilling or disking). Fine grade free of humps and hollows and free of deleterious and refuse material. Seed immediately afterwards.

3.05 Hand seeding:

A. Commence seeding once the Engineer has collected labels from seed bags showing:

1. Seed composition and percentage of pure seed;
2. Weight (net mass);
3. Percentage germination;
4. Name and address of grower/supplier.

B. Hand seeding to be executed in two applications. Seed area with half amount of the seed mixture. Once area has been seeded, take the second half and spread it evenly across the same area, applying the mixture perpendicular to the first pass.

C. Rake seed mixture so that it is lightly covered with soil, 3 mm to 6 mm deep.

D. Roll site with a roller to firm the seed into the soil. Do not roll if soil is wet. Wait until the soil is dry to avoid unnecessary soil compaction.

E. Apply light covering of clean, weed-free mulch. Do not use field hay.

F. Blend applications into adjacent grass areas or into previous applications to form uniform surfaces.

G. Re-seed at two week intervals where germination has failed. This is a contractual requirement and no extras will be paid to the contractor for this requirement.

3.06 Seed Placement on Slopes:

A. Hydroseed and mulch the sloped surfaces and cover them with anchored erosion control blankets.

3.07 Acceptance of Seeded Areas:

A. Areas will be accepted by the Engineer provided that:

1. Seeded areas are properly established.
2. The Engineer has collected labels from seed mixture containers verifying seed mixture and quantities are as per contract documents.

3.08 Tree Planting:

A. Plant, wrap and prune trees specified and in conformance with the details shown on the Drawings.

B. Implement erosion control measures such as (i) temporary plantation, (ii) water spray for dust control during construction.

C. Plant atleast four saplings for every tree uprooted within the project site.

D. Preserve at least 15% of the natural topography of the site to encourage natural habitat.

E. Preserve or transplant 75% of the existing trees within the project site.

END OF SECTION 02480.

SECTION 02520 SURFACE DRAINAGE SYSTEM

PART 1 -GENERAL

1.01 Reference:

A. Section 02000 applies to and governs the work of this Section.

1.02 Work Included:

A. The work under this section consists of providing materials, labour, equipment, tools and other accessories necessary to construct surface storm water drains within the pumping station sites.

B. The Drawings, Datasheets and Specifications are intended to set the acceptable minimum standard.

1.03 Related Work:

A. The following related work is covered elsewhere in the Contract Documents:

1.	Division 3	-	Concrete
2.	Division 4	-	Masonry
3.	Division 9	-	Finishes

1.04 Alternatives:

A. Not applicable for this section.

1.05 Submittals:

A. Submit drawings and product data in accordance with Section 01300 and AS-BUILT drawings as per section 01700.

B. Submit setting out line drawings for storm water drainage system.

C. Sample bricks shall be forwarded to the Engineer for approval.

D. Mix design of concrete shall be submitted to engineer.

1.06 Codes and Standards:

A. The following applicable standards established by the Bureau of Indian Standards govern the materials and workmanship for the work under this Section:

1.	IS 269	Specification for 33 grade ordinary Portland cement
2.	IS 8112	Specification for 43 grade ordinary Portland cement
3.	IS 12269	Specification for 53 grade ordinary Portland cement
4.	IS 455	Specification for Portland slag cement
5.	IS 2212	Specification for bricks

B. Where provisions of the pertinent codes and standards conflict with these Specifications and Drawings or with each other comply with the more stringent provision.

C. Use the latest issue of Standards.

PART 2 - PRODUCTS

2.01 General:

A. All surface storm water drains shall be constructed to the correct sizes and shapes in accordance with the Drawings. The finished product shall be sound and shall have smooth top and inside surfaces. The system shall be in RCC type of construction.

2.02 Poured in Place Concrete Base:

A. Refer to Division 3.

2.03 Common Bricks:

A. Refer to Section 04200-Masonry.

2.04 Plaster:

A. Where specified, plaster shall be rendered 20 mm thick in cement mortar consisting of one part cement to three parts of sand. Plasticizer may be used with cement with the approval of the Engineer.

PART 3 - EXECUTION

3.01 Centre Line:

A. The center lines shall be marked with stakes at not more than 15 metre intervals and at turning points and positions of manholes, with the lines and levels of cut for drain laying clearly set out.

3.02 Laying of Surface Storm Water Drains:

A. Surface drains shall be laid in trenches dug to correct levels and alignment and constructed to produce a neat even alignment and gradient. Over-excavation shall be made good by selected fill well compacted and to the satisfaction of the Engineer.

3.03 Concrete work:

A. Cement concrete shall be minimum of M20 grade.

B. Newly laid concrete shall be protected from the harmful effects of sunshine, rain and running surface water and shocks. Any work that is damaged shall be taken down and re-built to the approval of the Engineer.

END OF SECTION 02520.

SECTION 02530 DEWATERING

PART 1 -GENERAL

1.01 Reference:

A. Section 02000 applies to and governs the work of this Section.

1.02 Work Included:

A. Pump out any water collected in excavations or trenches etc and keep the site dry for laying the foundation of structures and pipe laying.

1.03 Related Work:

A. The following related work is covered elsewhere in the Contract

1. Documents: Section 02220 - Excavation

1.04 Alternatives:

A. Not applicable for this Section

1.05 Submittals:

A. Not applicable for this Section

1.06 Codes and Standards:

A. Not applicable for this Section

PART 2 - PRODUCTS

2.01 General:

A. Provide and work all pumps/ engines and machinery requisite to keep excavations pipes, drains or foundations and all other excavations clear of water, whether sub-surface water, or surface water including storm water, leakage from tanks, wells drains, sewers, water mains, tide water etc or pipes so that there may be no accumulation of such water and that, no masonry shall be laid, no concrete deposited, no joints made in standing water.

B. Continue pumping for as long as necessary. Where ground water is encountered or anticipated, provide sufficient pumps to handle the ingress of water and provide and maintain, in working order, standby pumping units to be available and employed in the event of mechanical failure of the duty equipment.

C. Arrange for continuous managing and operating of the pumps wherever necessary to ensure that at all times and weather the work may proceed without delay.

D. Do not allow any accumulation of water either from the discharge of the dewatering pumps or the water connections on the site of the Work. If an accumulation is unavoidable, it shall be treated with insecticides to the satisfaction of the Engineer.

END OF SECTION 02530.

SECTION 02600 GRAVITY MAIN AND BYPASS

PART 1 -GENERAL

1.01 Reference:

A. Section 02000 applies to and governs the work of this Section.

1.02 Work Included:

A. Scope of work for gravity mains and bypasses includes, but is not necessarily limited to:

1. Supply, installation, testing and commissioning of gravity mains, bypasses and pipe networks from the pumping stations or other structures from one metre beyond the outside face of the structure wall to the discharge point/balancing chamber.
2. The piping systems include expansion joints and the other pipe fittings.
3. The Drawings, Datasheets and Specifications are intended to set the acceptable minimum standard. Ensure that the installed system is trouble-free and meets performance requirements.

1.03 Related Work:

A. The following related wok is covered elsewhere in the Contract Documents:

1. Division 1 - General Requirements
2. Division 2 - Site work, excavation, Backfill, etc.
3. Division 3 - Concrete
4. Division 15 - Mechanical

1.04 Alternatives:

A. Not Applicable for this section.

1.05 Submittals:

A. Submit shop drawings and product data as specified in accordance with Section 01007- Submittals, and As-Built drawings as per Section 01016.

B. Submit existing utility drawing and crossing details.

C. Submit manufacturers test reports.

1.06 Codes and Standards:

A. The following applicable standards established by the Bureau of Indian Standards govern the materials and workmanship for the work under this Section:

1.	IS 4111 (Part IV):	- Code of practice for ancillary structures in sewerage system Part IV pumping stations and pumping mains (Rising main).
2.	IS 8329:2000	- Centrifugally cast (spun) Ductile Iron pipes for Water, Gas and Sewage- Specifications.
3.	IS 9523:2000	- Ductile iron fittings for pressure pipes for water, gas and sewage - specification
4.	IS 14845:2000	-Air Release Valve
5.	IS 5382:1985	-Rubber Gaskets for DI Pipes

6. IS 13620 -Fusion Bonded Epoxy Coating

B. Where provisions of the pertinent codes and standards conflict with these Specifications and Drawings or with each other, comply with the more stringent provision

C. Use the latest issue of Standards.

1.07 Protection:

A. Use appropriate means necessary to protect materials of this Section before, during and after installation and to protect objects designated to remain in operation during construction under this Contract.

B. In the event of damage, immediately make all repairs and replacements necessary, to the satisfaction of the Engineer.

PART 2 - PRODUCTS

2.01 General:

A. The following product specifications cover some products, which are not specifically required on this project. Actual pipe materials required are as noted on the Drawings /Specifications.

B. Where there are conflicts between specified products and those shown on the Drawings, the more stringent requirements govern.

2.02 Materials:

A. Ductile Iron Pipe:

1. Refer to Section 15064.

2. Centrifugally cast (spun) ductile iron pressure pipe confirming to IS: 8329/2000 (Latest Revision) suitable for Tyton (rubber gasket) jointing in Class K7/K9.

3. The pipes shall be internally cement mortar lined as per Annexure B of IS:8329/2000 and externally coated with metallic zinc as per Annexure A of IS:8329 with finishing layer of bituminous coating as per the Annexure C of IS:8329.

4. The styrene butadiene rubber (SBR) gaskets for use with DI pipes shall conform to IS:5382/1969 (or its latest revision).

5. Provide pipes with lay flat tubular polyethylene film wrap conforming to Annexure D of IS:8329/2000.

6. Restrain joints to be capable of withstanding the pipe design pressure without the use of blocking.

7. Approved Suppliers / Manufacturers of DI Piping.

a) M/s. Electro Steel Castings Ltd., Kolkata

b) M/s. Kejriwal Castings Pvt. Ltd, Kolkata

c) Or equivalent as approved.

B. Valves:

1. Valves to be provided in accordance with Section 15100.

C. Expansion Joints, Anchors and Guides:

1. Expansion joints anchors and guides to be provided in accordance with Section -15516.

2.03 Miscellaneous Appurtenances:

A. Provide the following miscellaneous appurtenances in accordance with the noted Division:

1. Division 3 - Concrete Thrust Blocks for Tees, Plugs and Horizontal Bends.
2. Division 3 - Concrete Thrust Blocks for Vertical Bends.

2.04 Corrosion Protection:

A. Protect ferrous valves, fittings, fasteners and bolted connections using Denso tape and paste wrap.

PART 3 - EXECUTION

3.01 General:

B. Install rising mains and bypasses as specified in this section.

C. Provide chambers with covers for combination air release/vacuum relief valves as required.

3.02 Bedding and Backfilling:

A. Earth Foundation:

1. Trim the bottom of the trench to conform to the lower portion of the pipe barrel for a width of at least 50% of the outer diameter and in such a manner that the pipes have a uniform bearing throughout their whole length.

2. Entirely surround the pipe to a height of at least 150 mm above the top of the pipe and to the full width of the trench with compacted approved fill.

B. Bedding:

1. Full Concrete Cradle to Spring Line:

a) Where concrete bedding is specified or required due to trench conditions, construct the bedding to the dimensions shown on the Drawings. After the trench has been prepared, carefully lay the pipe to line and grade and support the pipe on precast concrete blocks.

b) After the pipe has been jointed and the pipe laying approved, place M20 concrete to the lines and grades shown on the Drawings. Take care to work the concrete under the pipe. To achieve this, place the concrete on one side of the pipe and work it under the pipe. Take care that the alignment and grade of the pipe are maintained. Place concrete on the other side of the pipe only after it has been worked completely under the pipe.

c) To ensure flexibility of the pipeline, a divider of fibre-board or other suitable material cut to shape shall be placed at each pipe joint to make a complete break in the continuity of the concrete protection.

d) Where it is deemed necessary by the Engineer, the concrete bedding may be placed in two pours. When the bedding is placed in two pours, do not place concrete until the initial slab poured has cured for a minimum of 24 hours. Key the two pours together.

e) Where the concrete cradle is poured to the sheathing of a trench, place at least one thickness of building paper between the sheathing and the concrete. Withdraw the sheathing without displacing or damaging the cradle.

f) Provide concrete thrust blocks on pressure lines on every bend as shown on the Drawings.

B. Backfilling:

1. Compact backfill using suitably sized compaction units. Hand tamping or light blade type mechanical tampers will be permitted within 300 mm above the pipe unless otherwise approved by the Engineer. Backfill shall be compacted to a minimum of 98% S.P.D.

3.03 Installation and Jointing:

A. Ensure that pipe, before being lowered into the trench is thoroughly cleaned of mud, stones, or other debris that has accumulated in or on the pipe. Examine the pipe for cracks, flaws or other defects. Do not use defective pipes in the work. Lower pipes into the trench, one length at a time, and rest firmly throughout its length on the pipe foundation. Ensure that each pipe length is truly butted against the previously laid pipe.

B. Ensure that trenches where pipe laying is in progress are kept dry and that no pipe is laid in water or upon wet bedding. Do not lay a length of pipe until the preceding length has been thoroughly embedded and secured in place to prevent any movement or disturbance of the finished joint. At the end of each working day, plug the open end of pipe securely to the satisfaction of the Engineer.

C. Perform cutting of pipe that may be required to the satisfaction of the Engineer.

D. Carry out the actual installation and jointing of the different types of pipe in accordance with the manufacturer's recommendations or as directed by the Engineer.

E. Lay the pipe true to line and grade with uniform bearing under the full length of the barrel of the pipe. Make suitable excavation to receive the bell or collar to ensure that these features do not bear upon the subgrade or bedding. Remove and relay any pipe that is not in true alignment or shows any undue settlement after laying.

F. Do not permit walking on or working over the pipe after it has been laid until there is at least 300 mm of cover over it, except as may be necessary in refilling the trench and compacting the backfill.

3.04 Protection from Settlement:

A. Provide a wide, flexible coupling where a pipe passes from a rigid structure to a buried earth condition.

B. Provide two couplings in tandem to allow for lateral displacement where shown on the Drawings. Install the first coupling 500 mm outside of the wall with a 500 mm spool piece between the couplings.

C. Ensure that all wetted, metal parts are of the same material or have been provided with the same corrosion protection as the pipes or are coated with fusion-bonded epoxy in accordance with IS 13620- Fusion Bond Epoxy Coating.

3.05 Restraining Pressure Mains:

A. Securely restrain plugs, caps, bends, tees etc against blow-outs. Repair damage caused by blow-outs etc that occurs in the mains that have been laid or re-laid under this Contract. Provide restraining in a manner prescribed on the Drawings or as directed in the field by the Engineer. Use thrust blocks in original ground and restrained joints in disturbed ground.

3.06 Valve Installation:

A. Install valves to the manufacturer's recommendations at locations and with the valve stem orientation as indicated on the Drawings.

B. Support valves located in valve boxes or valve chambers by means of concrete, located between valve and solid ground. The bedding to be the same as for the adjacent pipe. Maximum length of pipe on each end of valve to be 1000 mm. Valves are not to be supported by the pipe.

3.07 Pipe Crossing or Exposure:

A. Support other utility pipes and other services that pass through the trench or excavation to the satisfaction of the Engineer.

3.08 Flushing:

A. Refer to Section 01650

3.09 Pipe Testing:

A. Refer to Section 01650 and 15060.

B. Pressure Pipe:

1. The test protocol: Apply a hydrostatic pressure of 150% of the maximum working pressure for the gravity main in question at the lowest point of the section under test for a period of at least 2 hours. The permissible leakage: not greater than 10 litres/100 mm diameter/100 m of pipe/day.

2. Leakage is defined as the quantity of water that must be supplied into the newly laid pipe to maintain the specified leakage test pressure after the air in the pipeline has been expelled and the pipe has been filled with water.

3. If any section under test discloses leakage in excess of the permissible amount specified, determine the cause and make required changes or repairs. Re-test that section, repeating the procedure until a satisfactory test result has been obtained.

4. Carry out pressure tests before backfilling, in the presence of the Engineer. The Engineer will document the tests. Repair visible leaks regardless of the results of the pressure/leakage test specified.

5. Provide labour, pumps, taps, bulkheads, drains, air valves, connections, gauges, fittings and other appurtenances necessary to carry out the leakage tests.

6. Ensure that proper arrangements are made for the disposal of water from the pipeline after completion of hydraulic testing.

END OF SECTION 02600.

SECTION 02610 SEWER CONNECTIONS

PART 1 -GENERAL

1.01 Reference:

A. Section 02000 applies to and governs the work of this Section.

1.02 Work Included:

A. Scope of work for interconnecting piping includes, but is not necessarily limited to, following:

1. Supply and installation of piping, fittings, manholes and appurtenances outside buildings and structures as specified herein after and as shown on the Drawings.
2. Site preparation as per Section 02100
3. Excavation of pipe trench as per Section 02220
4. Supply of material and backfill trench as per Section 02221
5. Reinstate existing road and pavement damaged during execution to original condition or better.
6. Supply and installation of RCC sewer pipe.
7. Pressure testing and flushing of pipes.

B. The Drawings, Datasheets and Specifications are intended to set the acceptable minimum standard. Ensure that the installed system is trouble-free and meets performance requirements

1.03 Related Work:

A. The following related work is covered elsewhere in the Contract Documents:

1. Division 3 - Concrete
2. Division 4 - Masonry

1.04 Alternatives:

A. Not Applicable for this section.

1.05 Submittals:

A. Submit drawings, product data and documents as required in accordance with Section 01007 and AS-BUILT drawings as per Section 01016.

B. Submit utility drawings, crossing details, special fittings and other products proposed to be used.

1.06 Codes and Standards:

A. The following applicable standards established by the Bureau of Indian Standards govern the materials and workmanship for the work under this Section.

1. IS 783 - Code of practice for Laying of Concrete Pipes
2. IS 456 - Code of practice for Plain & Reinforced Concrete
3. IS 13620 - Fusion Bonded Epoxy Coated Reinforcement
4. IS 458 - RCC Spun Pipes NP2 class

5. IS 784 - Prestressed RCC pipes

B. Where provisions of the pertinent codes and standards conflict with these Specifications and Drawings or with each other comply with the more stringent provisions.

C. Use the latest issue of Standards.

PART 2 - PRODUCTS

2.01 General:

A. The following product specifications cover some products, which are not specifically required on this project. Actual pipe materials required are as noted on the Drawings.

B. Where there are conflicts between specified products and those shown on the Drawings, the more stringent requirements govern.

2.02 Pipe Materials:

A. Concrete Gravity Sewer Pipe:

1. The pipes shall be RCC spun pipes NP2 class and shall be subject to the approval of the Engineer for soundness before incorporation in the work.

2.03 Corrosion Protection:

A. Protect ferrous valves, fittings, fasteners and bolted connections using Denso tape and paste wrap.

PART 3 - EXECUTION

3.01 Protection:

A. Use appropriate means necessary to protect materials of this Section before, during and after installation and to protect objects designated to remain in operation during construction under this Contract.

B. In the event of damage, immediately make all repairs and replacements necessary, to the satisfaction of the Engineer.

3.02 Laying of RCC Pipes

A. The laying of RCC spun pipes and accessories shall be executed in accordance with IS 783 and in accordance with the manufacturer's instructions.

B. Install bedding, surround and backfill as specified in section 02221 of the specification and as shown on the drawings.

C. Install appurtenant facilities on the pipeline such as manholes, chambers, inlet structures and catch basins as specified and shown on the drawings.

D. Lay pipes from downstream to upstream with the socket end at the upstream end of each pipe.

E. The pipeline shall be within 20mm of the specified line and the invert level shall be within 6mm of the specified value and shall be such that there is no back-fall at any point.

F. When a cut pipe is required, ensure that the cutting is done by a machine, leaving a smooth cut at right angles to the axis of the pipe.

G. When installing pipes, ensure the joint is cleaned and lubricated and that the rubber gasket is inserted in the groove of the socket end of the pipe. Align the spigot and insert home in the socket end. Use a metal feeler to check that the rubber gasket is correctly located. Spigot and socket flexible joints shall have the annular space between the pipe and socket sealed with an approved joint sealant to prevent the ingress of loose material or concrete. This sealing shall be carried out immediately on completion of a satisfactory initial hydraulic test prior to concreting or backfilling but not prior to the test.

H. Ensure that all pipes and fittings are sound and clean before laying. When pipe laying is not in progress, ensure that the pipe ends are at all times fitted with watertight plugs or caps. The plugs or caps shall only be removed for the purposes of making a connection of the pipe end or testing the pipeline. The plugs or cap shall be replaced immediately on completion of the test.

3.03 Joints

A. The joints between concrete pipes shall be spigot and socket with elastomeric joint rings. Caulked joints shall not be used.

3.04 Bedding and Backfilling:

A. General: bedding and backfilling to comply with Section 03300, Section 02221 and the Drawings.

3.05 Protection from Settlement:

A. Provide a wide, flexible coupling where a pipe passes from a rigid structure to a buried earth condition.

3.06 Pipe Crossings or Exposures:

A. Support any pipe or other utility that passes across the trench or excavation to the satisfaction of the Engineer.

3.07 Flushing:

A. Refer to Section 01650

3.08 Pipe Testing:

A. General:

1. Refer to Section 01650

B. Gravity Sewers and Drains:

1. Conduct infiltration/exfiltration tests as directed by the Engineer on gravity sewers and pipes under this Contract. Provide labour, tools and equipment necessary to carry out the infiltration/exfiltration tests. Ensure that the total infiltration/exfiltration does not exceed 30 litres/100 mm diameter/100 m of pipe/day. Make repairs as deemed necessary by the Engineer in order to reduce excess infiltration/exfiltration to the allowable limit.

3.09 Field Testing of Storm and Sanitary Piping:

A. Repair or replace pipes, pipe joints or bedding found defective.

B. When directed by the Engineer, draw a tapered wooden plug, with diameter of 50 mm less than the nominal pipe diameter, through the sewer pipe to ensure that it is free of obstructions.

C. Remove foreign materials from the pipe and related appurtenances by flushing with water.

3.10 Manholes:

A. Manholes are to be constructed wherever there is a change of direction of sewer gravity line. Sewer manholes are constructed in bricks and/or RCC as per the Drawings.

B. Brick manholes are either of rectangular shape or circular depending on depth of manhole. Up to depth of 1.5 m manholes are rectangular in shape and are constructed of 230 mm brick wall. For depth between 1.5 m to 3.0m they are circular in shape with 230 mm thick brick work. Depending upon depth greater than 3.0 m they are constructed with 350mm thick or 450mm thick masonry at bottom and top 2m of 230 mm thick masonry.

C. Manholes will have base of minimum 200mm thick concrete. Brick walls inside and outside will be plastered with water proof plaster. At bottom of manhole benching is constructed in M20 concrete as shown on Drawing

D. RCC manholes are constructed as shown in drawing

E. Provide CI. manhole cover.

END OF SECTION 02610.

SECTION 02720 ROADS AND PAVINGS

PART 1 -GENERAL

1.01 Reference:

A. Section 02000 applies to and governs the work of this Section.

1.02 Work Included:

A. Roads and paved areas required for this Contract include, but are not necessarily limited to, the construction of new roads, hardstanding areas and walkways as specified herein and as shown on the Drawings.

B. Scope of work also includes the reinstatement of existing roads and paved surfaces walkways and kerbs excavated or damaged during trenching and excavation.

C. The Drawings, Datasheets and Specifications are intended to set the acceptable minimum standard.

1.03 Related Work:

A. The following related work is covered elsewhere in the Contract Documents:

1.	Section 02100	-	Site Clearing and Grading
2.	Section 02220	-	Excavation
3.	Section 02221	-	Backfilling and filling
4.	Section 02530	-	Dewatering
5.	Section 02600	-	Rising Main
6.	Division 3	-	Concrete
7.	Division 15	-	Piping
8.	Division 16	-	Electrical

1.04 Alternatives:

A. Refer to Section 01002 for requirements pertaining to acceptance of alternative method.

1.05 Submittals:

A. Submit As- Built drawings as per Section 01016.

B. Submit to the Engineer a detailed construction procedure prior to commencement of work, along with the drawings of the layout of the proposed roads, hardstanding areas and walkways.

C. Submit to the Engineer, every four weeks, a construction report detailing the load tests.

1.06 Codes and Standards:

A. The following applicable standards established by the Bureau of Indian Standards govern the materials and workmanship for the work under this Section:

1	IS: 3764	Safety code for Excavation Work
2	IS: 2720 Part II	Determination of Moisture Content
	IS: 2720 Part VII	Determination of Moisture content dry density relation using light compaction

	IS: 2720 Part VIII	Determination of Moisture content dry Density using heavy compaction.
3	IS: 73	Specification for Paving Bitumen
4	IS: 215	Specification for Road Tar
5	IS: 217	Specification for Cutback Bitumen
6	IS: 454	Cutback Bitumen from waxy crude – Specification
7	IS: 460	Specification for Test Sieves (Parts 1 to 3)
8	IS: 1077	Specification for common burnt clay building bricks
9	IS: 1124	Method of test for determination of water absorption, apparent specific gravity and porosity of natural building stones.
10	IS: 1195	Specification for Bitumen Mastic for Flooring
11	IS: 1196	Code of Practice for Laying Bitumen Mastic Flooring
12	IS: 1834	Specification for Hot Applied Sealing Compounds for Joints in concrete.
13	IS: 2386	Methods of tests for aggregates for concrete. (Parts 1 to 8)
14	IS: 2720	Methods of Test for Soils - Part 5: Determination (Part 5)of Liquid and Plastic Limit
15	IS: 6241	Method of test for determination of stripping value of road aggregates
16	IRC: 16	Specification for priming of base course with bituminous primers
17	IRC: 17	Tentative specification for single coat bituminous surface dressing.
18	IRC: 19	Standard specification and code of practice for water bound macadam
19	IRC: 29	Specification for bituminous concrete (Asphaltic concrete) for road pavement
20	Ministry of Surface Transport (Roads Wing)	Specifications for road and bridge works

B. Where provisions of the pertinent codes and standards conflict with these Specifications, Drawings and Datasheets or with each other, comply with the more stringent provisions.

C. Use the latest issue of Standards.

PART 2 - PRODUCTS AND EXECUTION

2.01 Roads and Paving Areas:

A. Base and Sub-Base: As specified in Section 02221 and as shown on the Drawings.

B. Asphalt Surface: Conform to Indian Standard Specifications for Hot Mix or Hot-Laid Asphalt and pre-mix top seal coat. The extent of asphalt paved areas is as shown on the Drawings and as affected by the construction.

C. Concrete: Material used for construction or restoration of concrete, roads, kerbs, gutters and/or sidewalks is as specified in Section 03300.

2.02 Other Materials:

A. Provide other materials and incidentals required for the proper completion of the work, but not specifically described in this Section subject to the Engineer's approval.

2.03 Excavation:

A. Excavation shall be completed generally in accordance with Section 02220.

2.04 Dewatering

A. Dewatering shall be completed generally in accordance with Section 02530

2.05 Filling and Backfilling:

A. Filling and backfilling shall be completed generally in accordance with Section 02221.

2.06 Preparation of Sub-grade:

A. Sub-grade shall be levelled approximately to the proper level and slope by filling depressions with excavated material and cutting off protuberances.

B. Sub-grade shall be prepared to have as uniform a bearing capacity as practicable and all hard spots to be properly excavated and refilled.

C. All soft and spongy parts of the subgrade shall be excavated and refilled with approved materials. layers for the same reason.

D. The subgrade shall be watered to the satisfaction of the Engineer at least 12 hours before being compacted.

E. Provide proper access for the roller to get to the sub-grade. Remove manhole frames and covers etc and replace them with plates whenever they interfere with the free rolling of the subgrade.

F. Trenches less than 600 mm. in depth may be filled with alternate layers of rubble and soil and properly consolidated without providing reinforcement on them.

G. After rolling, the camber, super elevation and longitudinal slope etc, the subgrade shall conform in shape to those of the finished road surface. This should be checked with the help of level stakes, strings and camber boards if necessary.

2.07 Stabilized Soil:

A. Approved soil with a CBR of not less than 10 (in soaked condition) shall be laid to the proper shape and camber to the required consolidated depth and satisfactorily rolled. Stabilized soil may be obtained by thoroughly mixing two or more soils, sand and stone dust or lime for the purpose. The mixed soil as prepared shall be made slightly moist before the same is spread and rolled.

B. The testing of the CBR values shall be done at the Contractor’s cost.

2.08 Kutcha Tough Metal (Inferior Quality Metal):

A. This metal shall be obtained from Kutcha tough rock. The Kutcha tough metal should stand rolling satisfactorily with a 10 tonne roller without getting crushed into powder. The metal shall be graded from 90 mm to 40 mm and spread over a prepared sub-base to a thickness of 120 mm and then compacted by a 10 tonne roller to a thickness of about 80mm.

B. The rate of spreading frit/dust/sand/burnt brick powder etc shall not be less than 3.35 m^3 per 100 m^2 for each layer. All other operations such as rolling and watering shall conform to the specifications.

2.09 Rubble Packing:

A. Soil to camber shall be properly consolidated by rolling with a heavy roller of not less than 10 tonnes to receive the 250 mm thick rubble foundation. Rubble shall be large and flat bedded and regular in shape.

B. The stone for rubble soling shall be of suitable quality and of not less than 250 mm in size. The stones shall be sound angular, durable and free from flaws such as salts cavities, bends etc. No earthy, weathered, fractured, perishable or water-worn stones or boulders shall be used. The stones shall be obtained from quarries or from boulders as approved by the Engineer.

C. All stones shall be hand packed and all voids shall be filled with chips and hammered in well. The stones shall be set on their natural bed. The layer of the rubble shall be composed of large stones. The soling shall be carried out to the required camber and grade in regular line to contour of the surface and the surface will be rolled by a power roller weighing not less than 10 tonnes. Each rubble piece shall have a horizontal base and shall be set vertically. All such rubble pieces shall be set and packed close to each other.

D. Large stones will be kept at the edges of the roadway to enclose and protect the top layers on the sub-grade and the area of soling will be measured superficially.

E. If the packing is required for road work or other similar purposes, a layer of 55 mm metal 80 mm thick shall be evenly spread over the rubble and the same shall be rolled and well consolidated by rolling with a heavy roller of not less than 10 tonnes.

2.10 Water Bound Macadam:

A. 60 mm metal shall be spread over the prepared base to a thickness of 120 mm. The metal layer shall then be rolled and compacted by a 10 tonnes power roller. The thickness of the compacted layer after completing all the operations described below shall not be less than 80 mm.

B. Rolling shall start from the edge of the road and proceed towards the crown in longitudinal strips overlapping on successive strips by at least one half the width of the rear wheel of the roller. The operation shall continue until no visible settlement of the metal or movement under the roller is observed. The gradient and camber shall be checked by means of level, stakes, strings, camber boards, etc. Any depression of hump shall be corrected by completely replacing the metal layer in the affected area and compacting until a satisfactory result is achieved.

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

D. The rate of spreading fines shall not be less than 3 m^3 per 100 m^2. The first layer of fines shall not be spread over a wet metal layer.

2.11 Dressing of Stones:

A. All faces of stones required to be dressed shall be true and without curved faces except where it is otherwise specified. The face of stones described as hammer dressed shall be as far as possible squared and levelled with a mason's hammer by knocking off all protuberances and ridges. Where it is described as very rough, the protuberances and ridges shall be further reduced with a chisel leaving the face truly level though rough with depressions. These depressions shall not be more than 25 mm in depth and 2000 mm^2 in area. Rough-dressed faces shall differ from those dressed very rough in having the depressions not more than 20 mm in depth and 1600 mm^2 in area. Where the face is required to be medium dressed, the depressions shall not be more than 10 mm in depth and 1000 mm^2 in area. In fair dressing the face shall be dressed fine but the chisel marks may be left visible in a few minute dimples not exceeding 6 mm in depth and 500 mm^2 in area scattered over it. In the dressing, neither chisel marks nor any dimples whatsoever shall be left in the face.

2.12 Kerb Stones:

A. Kerb stones shall be of a good quality to the approval of the Engineer. The stones to be not less than 300 mm in length, 300 mm deep and tapering from 150 mm wide at the bottom to 100 mm at the top. The variation in depth to be not more than ± 25 mm. Stones to be uniform in texture and free from veins, foreign matter, bands, laminations or similar defects. A tolerance of 3 mm in the width of one kerb stone will be permitted for 25 percent of total quantity of stones provided. Kerb stones shall be free from all unsightly projections and hollows and be cut truly square. Stones to be medium dressed on the top and to a depth of 230 mm on its exposed face and to a depth of 160 mm on two sides. The kerb stone, when placed in position, shall rest evenly on its bed and be set in 1:2 cement mortar over a bed of 1:3:6 cement concrete, 230 mm wide and 160 mm thick.

B. The joints between two kerbs shall not be more than 20 mm wide and the same shall be pointed flush in cement mortar (1:2). The kerbs stones to be laid on the curves shall be dressed to the required curvature before being placed. The work for providing and laying kerb stones shall include the necessary excavation.

2.13 Water Tables (Gutters):

A. The water tables shall be prepared from the stones of appropriate quality from an approved quarry. Stones shall be of a uniform width of 300 mm on top and not less than 230 mm at bottom and 300 mm to 450 mm in length on top and not less than 230 mm to 375 mm at bottom; the variation in dimensions between top and bottom being not more than ± 40 mm. Each water table shall be fair dressed and properly squared on top so that all corners shall be right angled. The bottom and sides shall be rough dressed and the sides sloped properly to not have any projection beyond the faces of the stone nor in a way to form thin edges. The water table shall be bedded on cement concrete (1:3:6) 160 mm thick and set in cement mortar (1:2) with joints flush pointed in cement and sand (1:2). The joints between water tables shall not be more than 12 mm wide.

2.14 Seat-Stones:

A. The seat-stones shall be prepared from appropriate quality stone from an approved quarry of blue trap stones. Stones shall be uniform in texture and free form veins, foreign matter, bands or laminations and other similar defects. Stones shall be 100 mm wide at the top and bottom, 160 mm to 230 mm in length and 160 mm in depth. The variations between the top and bottom widths and depth and between the lengths at the top and bottom shall not be more than 12 mm. Each set shall be properly dressed and squared on all its faces and shall be rectangular on the top and bottom and shall have its sides and ends cut truly square with the top surface. The tops shall be fair dressed and all the other faces including the bottom shall not have any depression exceeding 12 mm. The joints between the sets shall not be more than 12 mm wide.

2.15 Raising or Lowering Manholes, Chambers, Water – Entrances

A. Required level shall be achieved in brickwork. The thickness of joints shall not exceed 10 mm. In no case shall the frame be supported by stone chips or broken bricks or asphalt mix.

B. All manhole frames shall be kept flush with the surface of the road. Frames shall be bedded on cement mortar on brickwork with a splayed fillet all around.

C. Water-gully frames at the edge of a road shall be fixed 12 mm lower than the water-tables.

D. The area to be paved around hydrants or sluice boxes shall be 1.53 m x 1.53 m and for air valve chambers 1 m x 0.6 m, the longer dimensions being along the direction of the main.

2.16 Specifications of Road Metals:

A. All metal shall be clean and free from earth and dust or other extraneous matter

1. Kutcha tough metal shall be obtained from Kutcha tough rock. The size shall be between 90 mm and 40 mm.
2. 60 mm size metal shall be obtained by breaking hard blue rap stone which shall have sharp edges and will be retained on a 40 mm mesh screen. The metal shall be clean and free from earth and dust or any other extraneous matter.
3. 40 mm size machine crushed road metal

I.S. Sieve Designation	Percentage passing
50 mm.	100
40 mm	85-100
20 mm	0-20

10 mm	0-5

4. 25 mm size machine crushed road metal

I.S. Sieve Designation	Percentage passing
31.5 mm.	100
25 mm.	70-100
20 mm.	0-30
10 mm.	0-5

5. 12.5 mm size machine crushed road metal

I.S. Sieve Designation	Percentage Passing
20 mm.	100
12.5 mm.	70-100
10 mm.	0-30
4.75 mm.	0-10

6. Grit with dust shall be of approved quality and shall conform to the following grading:

I.S. Sieve Designation	Percentage passing
6.3 mm.	100
4.75 mm	90-100
2.36 mm	60-85
1.18 mm	40-65
600 micron	30-50
300 micron	20-30
150 micron	10-20
75 micron	5-10

Limits for the Requirements of Aggregates:

Sr. No.	**Test**	**Limit for the aggregate to be used for road base and surfacing**	**Limit for the aggregate to be used for sub-base (Kutcha tough metal)**
1	Specific Gravity	Not less than 2.6	Not less than 2.0
2	Water Absorption	Not more than 2 per cent	Not more than 5 per cent
3	Flakiness Index	Maximum 25 per cent	-
4	Elongation Index	Maximum 40 per cent	-
5	Aggregate Impact Value Or	Not more than 30 percent	Not more than 40 percent.
6	Aggregate crushing Value	Not more than 30 percent	Not more than 40 percent.
7	Los Angeles Abrasion Value	Not more than 30 percent	Not more than 50 percent

8	Stripping Test (C.R.R.I)	Maximum 15 percent	-

2.17 Specification of Bitumen:

Sr. No.	Characteristic	Requirement for Grade		Method of Test Reference to
		S 35	S 65	
1.	Specific gravity at 27°C, Min.	0.99	0.99	IS : 1202
2.	Water prevent by weight, Max.	0.2	0.2	IS : 1211
3.	Flash point, Pensky Martens closed type °C, Min.	175	175	IS : 1209 (Method A)
4.	Softening point, °C	50 - 65	40 - 55	IS : 1205
5.	Penetration, at 25°C, 100 g, 5 sec in 1/100 cm	30 - 40	60 - 70	IS : 1203
6.	Ductility at 20 °C in cm, Min	50	75	IS : 1208
7.(a)	Loss on beating, percent by weight, Max.	1	1	IS : 1212
7.(b)	Penetration of residue (expressed as percentage of item 5), Min	60	60	IS : 1203
8.	Matter soluble in carbon disulphide, percent by weight, Min.	99	99	IS : 1216

2.18 Priming:

A. Asphalt primer coat of low viscosity cutbacks shall be applied to water bound macadam preparatory to any superimposed treatment or construction if a dustless stone mosaic surface cannot be obtained by cleaning. The rate of application shall be 195 kg per 100 m^2. The primer shall be spread under capacity voids and to coat and bind surface dust, loose mineral particles etc and ensure a good adhesion between the old surface and the new bitumen film.

2.19 Specification for Premix (Hot Mix) Seal Coat:

A. 12 mm to 20 mm thick premix seal coat

B. Aggregate Grading

BS Sieve Designation	Percentage Passing
6 mm	100
5 mm	86-100
No. 7	60-78
14	42-58
25	26-41
52	14-26
100	6-15
200	4-10

C. The lime filler shall not be less than 6% by weight of total mix.

D. Bitumen 60/70 penetration – 6.25 (+0.25) per cent by weight of total mix.

2.20 Specification for Tack Coat:

A. The entire surface of the existing concrete or bituminous base on which the treatment is to be superimposed shall be cleaned thoroughly with plastic brooms and wire brooms if necessary. No foreign matter shall remain on the surface. The surface shall then be swept clean with clean gunny bags. A tack coat of bitumen emulsion shall then be applied evenly to the entire surface with plastic brooms at the rate of 75 kg per 100 m^2 leaving no part of the surface unpainted.

2.21 Specification for Providing and Laying Hot-Mix Asphaltic Concrete

A. Asphalt carpet shall conform to the BS 594 of 1958, BS 410, BS 598 and BS 812 or equivalent IS.

B. Unless otherwise shown, asphaltic concrete will be laid in two layers:

1. A binder (base) course laid to a thickness of 40 mm to 50 mm after consolidation.
2. A surface (wearing) course laid to a thickness of 40 mm after consolidation.

C. The bitumen to be used shall be of 60/70 penetration or as certified and shall have properties as per Table 4 of BS 594 or equivalent IS.

D. The filler added shall be dry and clean limestone powder or hydrated lime, having CaO content of not less than 60 percent and properties as per Table 4 of BS 594 or equivalent Indian Standard

E. The sand shall consist of approved clean, hard, non-absorbent sand.

F. The coarse aggregate shall consist of clean trap stone of approved quality, free from dust and angular but not flaky.

G. The grading, composition and characteristics of the binder (base) course mix shall be as given below:

IS Sieve Designation	Percentage Passing
25 mm.	100
20 mm	75-100
12.5 mm	50-75
10 mm	40-62
6.3 mm	30-50
2.36 mm.	18-35
1.18 mm.	12-27
600 micron	8-20
300 micron	5-17
150 micron	3-12
75 micron	0-8

Bitumen 5.25 to 5.75 per cent by weight of total mix.
Voids 4 per cent to 7 percent by volume.

H. The grading composition and characteristics of the surface course mix shall be as given below:

IS Sieve Designation	Percentage Passing

20 mm	100
12.5 mm	80-100
10 mm	70-90
4.75 mm	50-70
2.36 mm	35-50
1.18 mm.	26-38
600 micron	18-29
300 micron	13-23
175 micron	8-16
75 micron	4-10

Bitumen 6.25 to 6.75 per cent by weight of total mix
Voids 3 per cent to 5 per cent by volume.
Marshall Stability 15.0 minimum
Flow 8-16

I. If, for any practical reason, grading stipulated earlier for the binder course and surface course cannot be adopted, written permission from the Engineer shall be obtained for any alternative grading for which the suitability should be established by laboratory tests.

J. Be responsible to see that the sub-grade is properly consolidated to give a uniform and adequate support to the asphalt carpet for the period of its useful life. A thin layer of sand or stone dust shall be spread over the compacted base and rolled before the asphaltic concrete carpet is laid where the base is water bound macadam, otherwise the concrete base shall be swept clean

K. The asphalt mix will be laid by a mechanical compactor and finisher, the final consolidation being by means of a tandem power roller weighing not less than 10 tonnes. In other respects the method of transporting hot mix, laying and compacting shall be in accordance with Clause 21 of BS 594. The cross falls from the crown to the water-tables or kerbs of the footpaths shall be between 1:40 to 1:50.

L. If the surface course mix is laid without a base course on an existing asphalt surface, a tack of bitumen at the rate 75 to 97 kg per 100 m^2 shall be applied to the existing surface.

M. Test the asphalt mixes daily and provide a copy of the test results shall be submitted to the Engineer for record. Tests shall include water absorption, stability flow, filler content, grading of aggregate, bitumen content, specific gravity and void content.

N. Provide access to all testing facilities at all times to the Engineer to inspect the testing.

O. Each lorry leaving the plant to be weighed on a weigh bridge and a challan must be issued in duplicate showing the weight of the material loaded in the lorry. When required by the Engineer, lorries shall be taken to another weigh bridge to check the weight of the materials stated on the challan.

P. During the progress of the work, further checks on the adequacy of the foundations by means of trial holes, plate bearing tests etc shall be made and any defects noted shall be brought to the attention of the Engineer. The Contractor shall submit his proposals for the necessary corrective action for the approval of the Engineer.

Q. Rectify defects in the asphalt paving to the satisfaction of the Engineer.

R. Defects in areas of asphalt pavement under guarantee shall, where they exceed the limits specified below be remedied immediately.

1. The limiting values of defects shall be as following:

a) Deformation by 25 mm in 3 metres

b) Cracks exceeding 1.5 metres in length or 3 mm in width

c) Disintegration of the surface exceeding 0.2 m^2 in area or 12 mm depth.

2.22 Specification for Hot Mix Asphalt Macadam:

A. The specification for asphaltic concrete shall apply to asphalt macadam also as far as mixing, weighing, transportation, laying, rolling etc are concerned.

50 mm to 80 mm thick Asphalt Macadam Aggregate Grading

I.S. Sieve Designation	Percentage Passing
40 mm.	100
25 mm.	50-100
12.5 mm.	26-50
6.3 mm.	18-30
1.18 mm.	10-20
75 micron	0-5

Bitumen (60/70 Penetration) content 4.00 to 4.50 per cent by weight of the total mix.

80 mm and above Aggregate Grading

I.S. Sieve Designation	Percentage Passing
50 mm.	100
40 mm	85-100
20 mm	0-20

Bitumen (60/70 penetration) Content 2.25 to 2.75 percent

2.23 Specification for Asphalt Macadam with Premixed Seal Coat:

A. Asphalt Macadam 62 mm thick after consolidation.

B. The bituminous macadam shall be laid by a mechanical compactor and finisher, the final consolidation being by means of power roller weighing not less than 10 tonnes. The finished surface shall not vary more than 12 mm above or below the designed level and the average thickness shall not be less than that specified.

C. The grading, composition and characteristics of the bituminous macadam shall be as follows:

I.S. Sieve Designation	Percentage Passing
50 mm.	100
40 mm	60-100
25 mm	30-70
20 mm	20-60
63 mm	10-20
2.36 mm	0-5

Bitumen (60/70 penetration) content 3.5 to 4 percent by weight of the total mix.

D. The bituminous macadam shall be prepared in a hot mix plant or the bitumen shall be cut back with a suitable solvent so that the heated cut back bitumen may be mixed with the aggregate. In either case, mixing shall be carried out in a power driven pugmill mixer and shall be continued until all the aggregate is coated.

2.24 Concrete Roads

A. Concrete roads shall be laid on a well compacted water bound macadam base. The well compacted macadam must be brushed clean so that metal surface is exposed.

B. Remove all loose soil and wet the surface with water. Apply cement slurry before placing concrete. Concrete to be poured to the required depth and vibrated with creed vibrator.

C. The surface should be broom finished. The concrete to be poured in alternate panels. Ensure that proper slope or camber is maintained.

D. The concrete to be cured for a minimum period of 15 days. All construction joints to be cleaned and filled with bitumen.

E. Where manholes or other covers are located in the road, the rectangular or square concrete surrounds to be cast subsequently.

END OF SECTION 02720.

SECTION 02730 BLOCK PAVING

PART 1 -GENERAL

1.01 Reference:

A. Section 02000 applies to and governs the work of this Section.

1.02 Work Included:

A. Paved areas required for this Contract include, but are not necessarily limited to, the construction of new roads, hardstanding areas and walkways as specified herein and as shown on the Drawings.

B. Scope of work also includes the reinstatement of existing roads and paved surfaces walkways and kerbs excavated or damaged during trenching and excavation.

C. The Drawings, Datasheets and Specifications are intended to set the acceptable minimum standard.

1.03 Related Work:

A. The following related work is covered elsewhere in the Contract Documents:

1.	Section 02100	-	Site Clearing and Grading
2.	Section 02220	-	Excavation
3.	Section 02221	-	Backfilling and filling
4.	Section 02530	-	Dewatering
5.	Section 02600	-	Rising Main
6.	Section 02720	-	Roads
7.	Division 3	-	Concrete
8.	Division 15	-	Piping
9.	Division 16	-	Electrical

1.04 Alternatives:

A. Refer to Section 01002 for requirements pertaining to acceptance of alternatives.

1.05 Submittals:

A. Submit As- Built Drawings as per Section 01016.

B. Submit to the Engineer a detailed construction procedure prior to commencement of work, along with the drawings of the layout of the proposed block paving roads, hardstanding areas and walkways.

C. Submit to the Engineer, every four weeks, a construction report detailing the load tests.

1.06 Codes and Standards:

The following applicable standards established by the Bureau of Indian Standards govern the	IS: 3764	Safety code for Excavation Work

materials and workmanship for the work under this Section: 1		
2	IS: 2720 Part II	Determination of Moisture Content
3	IS: 2720 Part VII	Determination of Moisture content dry density relation using light compaction
4	IS: 2720 Part VIII	Determination of Moisture content dry Density using heavy compaction.
5	IS: 460	Specification for Test Sieves (Parts 1 to 3)
6	IS: 1124	Method of test for determination of water absorption, apparent specific gravity and porosity of natural building stones.
7	IS: 2386	Methods of tests for aggregates for concrete. (Parts 1 to 8)
8	IS: 2720	Methods of Test for Soils - Part 5: Determination (Part 5)of Liquid and Plastic Limit
9	Ministry of Surface Transport (Roads Wing)	Specifications for road and bridge works
10	IS: 13801	

A. Where provisions of the pertinent codes and standards conflict with these Specifications, Drawings and Datasheets or with each other, comply with the more stringent provisions.

B. Use the latest issue of Standards.

PART 2 - PRODUCTS AND EXECUTION

2.01 Paving Tiles:

A. Materials: Pre-cast concrete paving tiles with or without perforation shall be manufactured and tested in accordance with IS: 13801, except as described below, to the approval of the Engineer.

B. Pre-cast concrete paving tiles shall be manufactured to the dimensions, patterns, and colours indicated on the drawings or as otherwise approved by the Engineer. The tiles shall be either 250 mm or 300 mm x 100 mm rectangular or to another size and shape as shown on the drawings or instructed by the Engineer.

C. Pre-cast concrete paving tiles shall be hydraulically pressed using a coloured concrete topping not less than 8 mm thick. The pre-cast concrete paving tiles shall have a minimum thickness of 33mm and shall be laid to the pattern indicated on the drawings or as approved by the Engineer.

D. The tiles shall be manufactured using a minimum of 350 kg cement per cubic metre of mix.

E. All tiles shall be free from segregation, honey-combing, broken or damaged corners and imperfect plane surfaces. Correction of any defects by a method of polishing or grouting shall not be allowed.

F. Paver Blocks for Footpaths: Interlocking paver blocks to be used for pedestrian ways and footpaths shall be 60mm thick. The average tensile splitting strength shall not be less than 2.8 MPa with a provision that no individual block shall have a strength of less than 2.6 MPa.

2.02 Paver Blocks / Interlocking Concrete Block Pavement:

A. The concrete pavers shall have perpendiculars after release from the mould and the same should be retained until the laying. The surface should be of anti-skid and anti-glare type. The pave should have uniform chamfers to facilitate easy drainage of surface run off. The pavers should have uniform interlocking space of 2mm to 3mm to ensure compacted sand filling after vibration on the paver surface.

B. The concrete mix design shall be followed for each batch of materials separately and an automatic batching plant shall be used to achieve uniformity in strength and quality.

C. The pavers shall be manufactured in single layers.

D. Skilled labour shall be employed for laying blocks to ensure line and level for laying, desired shape of the surfaces and adequate compaction of the sand in the joints.

E. The pavers shall be skirted all round with kerbing refer to 02720 for kerb specification.

F. Refer to 03300 for sand specification.

G. Sampling and Testing Procedures for Paver Blocks:

1. Sample Size: Following are the sample sizes:
   a) Internal: Average of minimum 3 samples per 5000 blocks – for paver block manufactures.
   b) External: Minimum 9 Blocks per 5000 Blocks. Average of minimum 9 Blocks per site: for captioned contractors.
2. Comprehensive Strength: The average comprehensive strength of the 80mm thick paver blocks tested shall be 45 N/ mm^2 and average comprehensive strength of the 60mm to 50mm thick paver blocks shall be 35 N/ mm^2.
3. Water Absorption: Testing for water absorption shall be in accordance with IS:2185 : 1979 : Part I (Specifications for Concrete Masonry Blocks) Appendix C.
4. In the event of a failure of the test sample in the above test, the Contractor shall replace the entire lot of paver blocks from which the samples were taken. The samples of replaced lots shall be tested.
5. Tensile Splitting Test: (for blocks subject to vehicular traffic) – The mean tensile strength of eight blocks shall be not less than 3.9 MPa and no individual block shall have a tensile strength of less than 3.6 MP when tested as per Annex E of BS 6717:2001.
6. Abrasion Resistance (blocks subject to vehicular traffic): A set of three blocks tested as per Annex F of BS 6717: 2001 shall be more than 23mm.
7. Method for the determination of Water Absorption:

a) The test specimens shall be completely immersed in water at room temperature for 24 hours.

b) The specimens shall then be weighed, while suspended by a metal wire and completely submerged in water.

c) They shall be removed from the water and allowed to drain for one minute.

d) Visible surfaces water being removed with a damp cloth, and immediately weighed.

e) Subsequently to saturation, all specimens shall be dried in a ventilated oven at 100 to 115o C for not less than 24 hours and until two successive weighings at intervals of two hours show an increment of loss not greater than 0.2 percent of the previously determined mass of the specimen.

f) The absorption shall be calculated as follows

$$\text{Absorption, Kg/m}^3 = \frac{A - B}{A - C} \times 1000$$

$$\text{Absorption Percent} = \frac{A - B}{B} \times 100$$

Where
A = wet mass of unit in kg
B = dry mass of unit in kg and
C = suspended immersed mass of unit in kg.

H. Sampling of Paver Blocks:

1. Method of Sampling: Before laying paver blocks, each designated section comprising not more than 50,000 blocks, shall be divided into ten approximately equal groups. Nine blocks shall be drawn from each group.
2. Marking and Identification: All samples shall be clearly marked at the time of sampling so that the designated section and the consignment represented by the sample are clearly defined. The sample shall be dispatched to the approved test laboratory taking precautions to avoid damage to the paving in transit. The samples shall be stored in water at 20°C ± 5°C for 24 hours prior to testing.

I. Procedure for Testing of Compressive Strength for Paver Blocks:

1. Testing Machine: The testing machines shall be of suitable capacity for the test and capable of applying the load at the required rate.
2. Procedure: the sample specimens shall be tested in a wet condition after being stored for at least 24 hours in water maintained at a temperature of 20°C ± 5°C.
3. The plates of the testing machine shall be wiped clean and any loose grit or other material shall be removed from the contact faces of the specimen. Plywood, nominally 4mm thick, shall be used as packing between the upper and lower faces of the specimen and the machine plates. These boards shall be larger than the specimen by a margin of at least 5mm at all points. Fresh packing shall be used for each specimen tested. The specimen shall be placed such that the axes of the specimen are aligned and pressure applied gently then increased continuously at the rate of 15 N/mm^2 per minute until no greater load can be sustained. The maximum load applied to the specimen shall be recorded.

4. Calculation of Corrected Strength: The Comprehensive strength of each block specimen shall be calculated by dividing the maximum load by full cross section area and multiplying by an appropriate factor.

Block Thickness (mm)	Correction Factors	
	Plain Block	Chamfered Block
60	1.00	1.06
80	1.12	1.18
100	1.18	1.24

5. Compressive Strength Calculation: The average corrected compressive strength for the designed block section shall be calculated.

J. Laying of Interlocking Paver Blocks:

1. Paver blocks shall be laid in a herringbone pattern throughout. Once the laying pattern has been established, it shall continue without interruption over the entire pavement surface. The cutting of blocks, the use of infill concrete or discontinuities in the laying pattern shall not be permitted in other than approved locations.
2. Paver blocks shall be placed on an un-compacted, screeded sand bed to the nominated laying pattern. The first block shall be located next to an edge restraint. Specially manufactured edge paving blocks are permitted, or edge blocks may be cut using a power saw, a mechanical or hydraulic guillotine or another approved cutting machine.
3. Paver blocks shall be placed to achieve gaps nominally of 2 to 3 mm wide between adjacent paving joints. No joint shall be less 1.5 mm or more than 4mm. String lines shall be used to check the alignment, which shall be corrected prior to initial compaction and before further laying is proceeded with.
4. Full blocks shall be laid first in each row and closure blocks shall be cut and fitted subsequently. Such closer blocks shall be not less than 25% of a full block.
5. Edge gaps between 25mm and 50mm wide shall be filled with 45 N/ mm^2 concrete with a nominal aggregate size not exceeding one-third of the smallest infill space. For smaller spaces dry packed mortar shall be used.
6. Except where it is necessary to correct any minor variations occurring in the laying, the paver blocks shall not be hammered into position. Where adjustment of paver blocks is necessary, care shall be taken to avoid premature compaction of the sand bedding.

K. Initial Compaction :

1. After laying the paver blocks, they shall be compacted to achieve consolidation of the sand bedding and brought to design levels and profiles by not less than two passes of a suitable plate compactor.
2. The compactor shall be a high-frequency, low amplitude mechanical flat plate vibrator having plate area sufficient to cover a minimum of twelve paving blocks. Prior to compaction all debris shall be removed from the surface.
3. Compaction shall proceed closely following laying and prior to any traffic. Compaction shall not be attempted within one metre of the laying face. Compaction shall continue until difference in level (lipping) has been eliminated between adjoining blocks. Joints shall then be filled and re-compacted.

4. All work further than one metre from the laying face shall be left fully compacted at the completion of each day's laying.
5. Any blocks that are structurally damaged prior to or during compaction shall be replaced.
6. Sufficient plate compactors shall be maintained at the site for both bedding compaction and joint filling.

L. Joint Filling and Final Compaction :

1. After compaction and prior to the termination of work on that day or the acceptance of vehicular traffic, sand for joint filling shall be spread over the pavement.
2. The sand shall be brushed to fill the joints. Excess sand shall be removed from the pavement surface and the jointing sand shall be compacted with at least one pass by the plate vibrator. Joints shall be refilled with sand to the full depth. This procedure shall be repeated until all joints are completely filled with sand. No traffic shall be permitted to use the pavement until all joints have been completely filled with sand and compacted.
3. Both the sand and paver blocks shall be dry when sand is spread and brushed into the joints.
4. The lipping between adjacent blocks shall not exceed 3mm with not more than 1% in any 3m x 3m area shall exceed 2mm. Any areas which are outside these limits after final compaction shall be taken out and reconstructed to the satisfaction of the Engineer.

M. Edge Restraint:

1. Edge restraints shall be sufficiently robust to withstand override by the anticipated traffic, withstand thermal expansion and prevent loss of the material from beneath the surfaces course. The edge restraints shall present a vertical face down to the level of the underside of the laying course.
2. The surface course shall not be vibrated until the edge restraint and any bedding or concrete haunching has gained sufficient strength. Edge restraints shall be adequately secured.

N. Base and sub-base shall be as specified in Section 02221 and as shown on the Drawings.

O. Concrete used for construction or restoration of roads, kerbs, gutters and sidewalks shall be as specified in Section 03300.

2.03 Other Materials:

A. The Contractor shall provide other materials and incidentals required for the proper completion of the work, but not specifically described in this Section subject to the Engineer's approval.

2.04 Other Works

A. Other works required to be carried out incidental to the paving works such as excavation, dewatering, filling and backfilling, preparation of sub-grade, stabilized soil, dressing of stones, kerb stones, gutters, seat-stones, raising or lowering manholes etc shall be carried out in accordance with Section 02720.

END OF SECTION 02730

SECTION 02750 BITUMINOUS CONCRETE ROADS

PART 1 -GENERAL

1.01 Reference:

A. Section 02000 applies to and governs the work of this Section.

1.02 Work Included:

A. The Contractor shall provide all tools, plants, instruments, qualified supervisory personnel, labour, materials, and temporary works, consumables, any and everything necessary, whether or not such items are specifically stated herein, for completion of the Work. The Contractor shall carry out the survey of the site before excavation and set properly all lines and establish levels for various works such as earthwork in excavation for leveling, roads, drains, trenches, pipelines etc. Such survey shall be carried out by taking accurate cross sections of the area perpendicular to established reference/grid lines at 5 m intervals or nearer as determined by Engineer/Agency based on ground profile. These shall be checked by Engineer/Agency and thereafter properly recorded.

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

C. All gold, silver, oil minerals archaeological and other findings of importance, all precious stones, coins, treasures, relics, antiquities and other similar things which may be found in or upon the site shall be the property of Employer and Contractor shall dully preserve the same to the satisfaction of Employer and from time to time deliver the same to such person or persons as Employer may from time to time authorise or appoint to receive the same.

D. Scope of work also includes the reinstatement of existing roads and paved surfaces walkways and kerbs excavated or damaged during trenching and excavation.

E. The Drawings, Datasheets and Specifications are intended to set the acceptable minimum standard.

1.03 Related Work:

A. The following related work is covered elsewhere in the Contract Documents:

1.	Section 02100	-	Site Clearing and Grading
2.	Section 02220	-	Excavation
3.	Section 02221	-	Backfilling and filling
4.	Section 02530	-	Dewatering
5.	Section 02600	-	Rising Main
6.	Division 3	-	Concrete
7.	Division 15	-	Piping
8.	Division 16	-	Electrical

1.04 Alternatives:

A. Refer to Section 01002 for requirements pertaining to acceptance of alternative method.

1.05 Submittals:

A. Submit As- Built drawings as per Section 01007.

B. Submit to the Engineer a detailed construction procedure prior to commencement of work, along with the drawings of the layout of the proposed roads, hardstanding areas and walkways.

C. Submit to the Engineer, every four weeks, a construction report detailing the load tests.

1.06 Codes and Standards:

A. The following applicable standards established by the Bureau of Indian Standards govern the materials and workmanship for the work under this Section:

1	IS: 3764	Safety code for Excavation Work
2	IS: 2720 Part II	Determination of Moisture Content
3	IS: 2720 Part VIII	Determination of Moisture content dry Density using heavy compaction.
4	IS: 2720 Part XXVIII	Determination of dry density of soils, in-place by the sand replacement method.
5	IS: 2720 Part XXIX	Determination of dry density of soils, in-place, by the core cutter method.
6	IS:2386	Methods of test for aggregates for concrete Parts I to VIII
7	IS: 73	Specification for Paving Bitumen
8	IS: 215	Specification for Road Tar
9	IS: 217	Specification for Cutback Bitumen
10	IS:383	Specification for coarse and fine aggregate from natural sources for concrete.
11	IS:458	Concrete pipes (with and without reinforcement)
12	IS: 460	Specification for Test Sieves (Parts 1 to 3)
13	IS: 2386	Methods of tests for aggregates for concrete. (Parts 1 to 8)
14	IRC: 16	Specification for priming of base course with bituminous primers
15	IRC: 17	Tentative specification for single coat bituminous surface dressing.
16	IRC: 19	Standard specification and code of practice for water bound macadam

17	IRC: 29	Specification for bituminous concrete (Asphaltic concrete) for road pavement
18	IRC: 48	Tentative specification for Bituminous Surface Dressing using Precoated Aggregates.
19	Ministry of Surface Transport (Roads Wing)	Specifications for road and bridge works

B. Where provisions of the pertinent codes and standards conflict with these Specifications, Drawings and Datasheets or with each other, comply with the more stringent provisions.

C. Use the latest issue of Standards.

PART 2 - PRODUCTS AND EXECUTION

2.01 General Requirements:

A. The Technical Specifications in accordance with which the entire work described hereinafter shall be constructed and completed by the Contractor shall comprise of the following:

1. Part-I: General Technical Specifications (MORT & H)

   The General Technical Specifications shall be the "Specifications for road and bridge works" (Fourth Revision, August 2001, Reprint, November 2008), issued by the Ministry of Shipping, Road Transport & Highways, and Government of India and published by the Indian Roads Congress, henceforth called MOSRT&H Specifications.

2. Part-II: Supplementary Technical Specifications (MORT & H)

   The Supplementary Technical Specifications shall comprise of various Amendments / Modifications / Additions to the "specifications for road and bridge works" referred to in Part-I above.

   A particular clause or a part thereof in "specifications for road and bridge works (Fourth Revision, August 2001, Reprint, November 2008)" referred in Part-I above, where Amended/Modified/Added upon, and incorporated in Part-II, referred to above, such Amendment/Modification/ Addition supersedes the relevant Clause or part of the Clause.

   When an Amended/Modified/Added Clause supersedes a Clause or part thereof in the said Specifications, then any reference to the superseded Clause shall be deemed to refer to the Amended/Modified/Added Clause or part thereof.

   In so far as Amended/Modified/Added Clause may come in conflict or be inconsistent with any of the provisions of the said MOSRT&H Specifications under reference, the Amended/Modified/Added Clause shall always prevail.

2.02 Earthwork in Box Cutting

A. Classification

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

1. All kinds of soils

   These shall include all kinds containing kankar, sand, silt, Murrum and/or shingle, gravel, clay, loam peat, ash, shale etc. which can generally be excavated by spade, pick-axe and shovel and which is not classified under soft and decomposed rock, and hard rock defined below. This shall also include embedded rock boulders not bigger than 1metre in any dimension and not more than 200 mm in any one of the other two dimensions.

2. Soft Rock

   This shall include rock, boulders, slag, chalk, slate, hard mica schist, laterite etc. which are to be excavated with or without blasting or could be excavated with picks, hammer, crow bars, wedges. This shall also include excavation in macadam and tarred roads and pavements. This shall also include rock boulders not bigger than 1 metre in any dimension and not more than 500 mm in any one of the other two dimensions Rubble masonry to be dismantled will also be measured under this item.

3. Hard Rock

   This shall include rock which cannot be easily excavated with pick-axes, hammer, crow bars and wedges but has to be either heated where blasting is prohibited or has to be blasted or to be chiselled out with mechanical breakers. They shall be stacked separately for measurement.

   The earth work in excavation shall be done as per the drawings up to required depths and levels and alignments in all sorts of soils. The depth of the foundation will be as per the drawing or as per the Engineer's instruction. The Contractor should do the lining work. Roots or trees met with during the excavation shall be cut and smeared with coal tar. Excavated earth shall be stacked at least 3 m away from the trenches or as per the Engineer's instructions, so that it may not damage the sides of the excavated trenches. The maximum lead for stacking the earth shall be 50 M, unless otherwise categorically specified in the item description.

   In firm soil if the excavation is deeper than 2 M the sides of the trenches shall be made bigger by allowing steps of 30 cm on either side so as to keep the slope 0.25: 1. In loose soft or slushy soil the width of the step shall be suitably increased or the sides sloped or shoring and strutting may be done as per the Engineer 's instructions.

   For excavation for drain work, the sides and the bottoms should be to the required slope, shape and gradient. The cutting shall be done from top to bottom. Under no circumstances shall undermining or under cutting be allowed. The final surface shall be neatly levelled and well compacted. The earth from the cutting shall be directly used for filling either in plinth or on grounds.

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

   If the trenches are made deeper than specified level due to oversight or negligence of the Contractor the extra depth shall be filled up by lean concrete of mix 1:5:10 (1 cement; 5 coarse sand and 10 coarse aggregate of nominal size 40mm) and if the trench is made wider than shown in the drawings the Contractor has to make good at his own cost. The foundation trenches shall be free from water and muck, while the foundation work is in progress.

The trenches which are ready for concreting shall be approved by the Engineer.

The excavated stacked earth shall be refilled in the trenches and sides of foundation in 250 mm layers and the balance surplus shall be first filled in layers in plinth and the remaining surplus shall be disposed off by uniform spreading within the site/ outside the site as directed by the Engineer .
Adequate protective measures shall be taken by the Contractor to see that the excavation for the building foundation does not affect the adjoining structure's stability and safety. The Contractor will be responsible if he has not taken precaution for the safety of the people, property or neighbour's property caused by his negligence during the constructional operations.
To the extent available, selected surplus spoils from excavated materials shall be used as backfill. Fill material shall be free from clods, salts, sulphates, organic & other foreign material. All clods of earth shall be broken or removed. Where excavated material is mostly rock, the boulders shall be broken into pieces not larger than 150 mm size, mixed with properly graded fine material consisting of Murrum or earth to fill up the voids and the mixture used for filling.
As soon as the work in foundations has been accepted and measured, the spaces around the foundations, structures, pits, trenches etc. shall be cleared of all debris and filled with earth in layers 20 cm to 25 cm, each layer being watered, rammed and properly consolidated before the succeeding one is laid. Each layer shall be consolidated to the satisfaction of Engineer.

B. Method of measurement for Earth work in excavation including back filling

1. Lead

Lead for deposition/disposal of excavated material, shall be as specified in the respective item of work. If the lead is not specified in the respective item, a basic lead anywhere within the site battery limit shall be considered. Unless otherwise specifically mentioned in the BOQ Item. For the purpose of measurement of lead the area to be excavated or filled or area on which excavated material is to be deposited/disposed off shall be divided into suitable blocks and for each of the blocks, the distance between centrelines shall be taken as the lead which shall be measured, as far as practically possible, by the shortest straight line route on the plan and not the actual route taken by the Contractor. No extra compensation is admissible on the grounds that the lead including that for borrowed materials had to be transported over marshy or katcha land/route.

All excavation shall be measured net. Dimensions for purpose of payment shall be reckoned on the horizontal area of the excavation at the base for foundations of the walls, columns, footings, tanks, rafts or other foundations structure to be built, multiplied by the mean depth from the surface of the ground in accordance with the drawings. Excavation for side slopes shall not be paid for. The Contractor may make such allowances in his rates to provide for excavation in side slopes keeping in mind the nature of the soil and safety of excavation. In soft/slushy soil or in firm soil if the excavation is deeper than 2m the sides of the trenches shall be made bigger by allowing steps of 50cm on either side so as to keep slope 0.25: 1. If concreting is proposed against the additional/extra excavation made by the Contractor shall be at his own cost.

Back filling as per specification the side of foundations of columns, footings, structures, and walls, tanks rafts, trenches etc. with excavated materials will not be paid for separately unless otherwise specifically provided for in the Item description. It shall be clearly understood that the rate quoted for excavation including back filling shall include stacking of excavated material as directed, excavation/stacking of selected stacked material, conveying it to the place of final backfill, compaction etc. as specified. As a rule material to be back filled shall be stacked temporarily within the basic lead of 50 metres unless otherwise specified in the item.

The rates quoted shall also include for dumping of excavated materials in regular heaps, bunds, prepare with regular slopes as directed by Engineer within the lead specified and levelling the same so as to provide natural drainage. Rock/soil excavated shall be stacked properly as directed by Engineer. As a rule, all softer material shall be laid along the centre of the heaps, the harder and more weather resisting materials forming the casing on the sides and the top. Excavated soft rock or hard rock shall be stacked separately.

The bailing or pumping out of water from excavation trenches, pits, etc. shall also be executed by the Contractor at his own cost, ensuring the trenches, foundation pits, etc. can receive the foundation material / concrete etc. without damages by the water.

2.03 Selected Earth Filling / Murrum Filling

A. Materials

Only materials considered suitable by the Engineer shall be employed for the construction and that considered unsuitable shall be disposed off as directed by Engineer.

The Contractor shall give the samples of earth proposed to he used for filling along with the following characteristics of the sample to Engineer, prior to use, for approval, in case filling material is brought from outside.

- Mechanical analysis or grain size analysis as per IS: 2720 part IV.
- Liquid Limit as per IS: 2720 part V
- Plastic Limit as per IS: 2720 part V
- Moisture density relationship as per IS : 2720 part VIII.

The material (soil) used for filling shall be free from boulders, lumps, tree roots, rubbish or any organic deleterious matter.

Material (soil) having plasticity index less than 20 shall be used for filling purposes.

Soil having laboratory maximum dry density of less than 95 lbs. per cubic ft. (1600 Kg/m3) shall not be used.

Care shall be taken to see that unsuitable waste material is disposed off in such a manner that there is no likelihood of its getting mixed with the materials proposed to be used for filling.

The work shall be so planned and executed so that the best available material (soil) is reserved for the top portion of embankments.

B. Procedure for Filling

The area where filling is to be placed must be cleared of all loose material and virgin soil must be exposed. Such exposed surface must be consolidated properly to obtain 90% of maximum laboratory dry density of the soil. All soft patches must be filled back and compacted.

Payment for the removal of loose top soil as described in clause above shall be included in the item for earthwork in filling. No separate payment for consolidation of exposed ground surface will be made. The rate quoted for the earth fill shall be inclusive of the cost of clearing and stripping, consolidation, including watering, testing etc. of the exposed ground.

Approved fill material shall be spread in uniform layers not exceeding 20 cms. in loose depth. All clods, lumps, etc. shall be broken before compaction.

In general the soil shall be spread in uniformity over the entire width of embankment. For large embankments the spreading of soil shall be as directed by Engineer.

Successive layers of filling shall not be placed until the layer under construction has been thoroughly compacted to satisfy the requirements laid down in this specification, and approved by the Engineer.

Prior to rolling, the moisture content of material shall be bought to within plus or minus 2 % of the optimum moisture content as described in IS: 2720 part VIII. The moisture content shall preferably be on the wet side for potentially expansive soils.

After adjusting the moisture content as described in clause the layers shall be thoroughly compacted by means of rollers till 95% of maximum laboratory dry density is obtained as per IS : 2720 part VIII.

Each layer shall be tested in field for density and accepted by Engineer subject to achieving the required density before laying the next layer.

The type of rollers that should be employed for compaction shall be as per direction of Engineer.

If the layer fails to meet the required density, it shall be reworked or the material shall be replaced and method of construction altered as directed by Engineer to obtain the required density.

The filling shall be finished in conformity with the alignment, levels, cross-sections and dimensions as shown in the drawings.

Extra material shall be removed and disposed off as directed by Engineer.

C. Quality Control

The Contractor shall establish and maintain quality control for various aspects of the work, method, material and equipment used. The quality control operation shall include but not be limited to the following items of work:

Lines, Levels and Grades

- Periodic survey
- Establishment of marks, boards etc.

Filling Material and Compaction

Soil suitable for consolidation under Optimum Moisture Content conditions should preferably have the following characteristics:

Grain Size Analysis

Percentage of Clay	15% to 25%
Percentage of Silt	30% to 45 %
Percentage of Sand	30% to 40 %
Percentage of Gravel	5% to 10%

Atterberg / Consistency Limits

Liquid limit	20 % to 35 %
Plastic Limit	20 % to 25 %
Plasticity index	should not more than 12 %
Shrinkage Limit	15 % and above
Free swelling Index	50 % Less than
Minimum Filling Material CBR in soaking condition shall be Min.	7 %

Various tests required to be conducted on the borrow material with their recommended frequency are indicated below. The frequency of testing indicated refers generally to the minimum number of tests to be conducted. The rate of testing must be stepped up as found necessary depending upon the variability of the materials and compaction methods employed.

- Gradation: At least one test for each kind of soil. Usual rate of testing 2 tests per 8000m^3 of soil.
- Plasticity: At least one test for each kind of soil. Usual rate of testing 2 tests per 8000m^3 of soil.
- Proctor Tests: At the rate of 1 per 800m^8 of soil.
- Deleterious Contents: As required.

D. Tolerance

Embankment for roads, units, etc. shall be carried to within a tolerance of 1.5 cm. from final lines but shall be to required grades and slopes.

E. Mode of Measurement - It shall be as per IS 1200

Measurement for filling shall be on cubic meter of volume calculated on the basis of cross sections plotted from the level of the ground surface prepared as described above, and from where filling is to be carried out and the levels reached after filling and the due consolidation.

Rates for embankment or fill formation should include cost of earth, transportation, breaking clods, laying / spreading, watering, consolidation, testing apparatus and testing the degree of consolidation, providing and operating including POL and operator charges of necessary road rollers and other equipment, dressing and levelling of sides and top surfaces, etc., including taxes, royalties, etc.

2.04 Granular Sub Base - 260mm

A. Scope

This work shall consist of laying and compacting well-graded material on prepared sub-grade in accordance with the requirements of these Specifications. The material shall be laid in one or more layers as sub-base or lower sub-base and upper sub-base (termed as sub-base hereinafter) as necessary according to lines, grades and cross-sections shown on the Drawings or as directed by the Engineer.

B. Material specification

The material to be used for the work shall be natural sand, Murrum, gravel, crushed stone, or combination thereof depending upon the grading required. Materials like crushed slag crushed concrete, brick metal and kankar may be allowed only with the specific approval of the Engineer. The material shall be free from organic or other deleterious constituents and conform to one of the three grading given in Table 1-1.

While the grading in Table 1-1 are in respect of close-graded granular sub-base materials, one each for maximum particle size of 75mm, 53mm and 26.5mm, the corresponding grading for the coarse-graded materials for each of the three maximum particle sizes are given at Table 1-2. The grading to be adopted for a project shall be as specified in the Contract.

1. Physical requirements

The material shall have a 10 percent fineness value of 50 KN or more (for sample in soaked condition) when tested in compliance with BS:812 (Part III). The water absorption value of the coarse aggregate shall be determined as per IS:2386 (Part 3):; if this value is greater than 2 percent , the soundness test shall be carried out on the material delivered to site as per IS:383. For Grading II and III materials, the CBR shall be determined at the density and moisture content likely to be developed in equilibrium conditions which shall be taken as being the density relating to a uniform air voids content of 5 per cent.

Table : Grading For Close-Graded Granular Sub-Base Materials

IS sieve	**Per cent by weight passing the IS sieve**		
Designation	Grade I	Grading II	Grading III
75.0 mm	100	-	-
53.0 mm	80-100	100	-
26.5 mm	55-90	70-100	100
9.50 mm	35-65	50-80	65-95
4.75 mm	25-55	40-65	50-80
2.36 mm	20-40	30-50	40-65

0.425 mm	10-25	15-25	20-35
0.075 mm	3-10	3-10	3-10
CBR Value (Minimum)	30	25	20

Table : Grading For Coarse Graded Granular Sub-Base Materials

IS Sieve	**Percent by weight passing the IS Sieve**		
Designation	Grading I	Grading II	Grading III
75.00 mm	100	-	-
53.0 mm		100	
26.5 mm	55-75	50-80	100
9.50 mm			
4.75 mm	10-30	15-35	25-45
2.36 mm			
0.425 mm			
0.075 mm	< 10	< 10	< 10
CBR Value (Minimum)	30	25	20

Note: The material passing 425 micron (0.425 mm) sieve for all the three grading when tested according to IS:2720 (Part 5) shall have liquid limit and plasticity index not more than 25 and 6 per cent respectively.

2. Strength of Sub-base

It shall be ensured prior to actual execution that the material to be used in the sub-base satisfies the requirements of CBR and other physical requirements when compacted and finished.

When directed by the Engineer, this shall be verified by performing CBR tests in the laboratory as required on specimens remoulded at field dry density and moisture content and any other tests for the “quality” of materials, as may be necessary.

C. Construction Specifications

1. Preparation of sub grade

Immediately prior to the laying of sub-base, the sub grade already finished shall be prepared by removing all vegetation and other extraneous matter, lightly sprinkled with water if necessary and rolled with two passes of 80-100 KN smooth wheeled roller.

2. Spreading and compacting

The sub-base material of grading specified in the Contract shall be spread on the prepared sub grade with the help of mechanical grader, of adequate capacity, its blade having hydraulic controls suitable for initial adjustment and for maintaining the required slope and grade during the operation or other means as approved by the Engineer.

When the sub-base materials consist of combination of materials mentioned in section 2.70 mixing shall be done mechanically by the mix-in-place method.

Manual mixing shall be permitted only where the width of laying is not adequate for mechanical operations, as in small-sized jobs. The equipment used for mix-in-place construction shall be a rotavator or similar approved equipment capable of mixing the material to the desired degree. If so desired by the Engineer, trial runs with the equipment shall be carried out to establish its suitability for the work.

Moisture content of loose material shall be checked in accordance with IS:2720 (Part 2) and suitably adjusted by sprinkling additional water from a truck mounted or trailer mounted water tank and suitable for applying water uniformly and at controlled quantities to variable widths of surface or other means approved by the Engineer so that, at the time of compaction, it is from 1 per cent above to 2 per cent below the optimum moisture content corresponding to IS:2720 (Part 8). While adding water, due allowance shall be made for evaporation losses. After water has been added, the material shall be processed by mechanical or other approved means like disc harrows, rotavator until the layer is uniformly wet.

Immediately thereafter, rolling shall start. If the thickness of the compacted layer does not exceed 100 mm, a smooth wheeled roller of 80 to 100 KN weight may be used. For a compacted single layer up to 225 mm. the compaction shall be done with the help of vibratory roller of minimum 80 to 100 KN static weights with plain drum or pad foot drum or heavy pneumatic typed roller of minimum 200 to 300 KN weight having a minimum tyre pressure of 0.7 MN/m^2 or equivalent capacity roller capable of achieving the required compaction. Rolling shall commence at the lower edge and proceed towards the upper edge longitudinally for portions having unidirectional cross fall (camber) and super elevation and shall commence at the edges and progress towards the centre for portions having cross fall (camber) on both sides.

Each pass of the roller shall uniformly overlap not less than one-third of the track made in the preceding pass. During rolling, the grade and cross fall (camber) shall be checked and any high spots or depressions which become apparent, corrected by removing or adding fresh material. The speed of the roller shall not exceed 5 km per hour.

Rolling shall be continued till the density achieved is at least 98 per cent of the maximum dry density for the material determined as per IS:2720 (Part 8). The surface of any layer of material on completion of compaction shall be well closed, free from movement under compaction equipment and from compaction planes, ridges, cracks or loose material. All loose, segregated or otherwise defective areas shall be made good to the full thickness of layer and re-compacted.

3. Surface Finish and Quality Control of Work

The surface finish of construction shall conform to the requirements of Section 902 of MoSRT&H Specifications for Road and Bridge Works (IV Revision).

Control on the quality of materials and works shall be exercised by the Engineer in accordance with Section 900 of MORT Specifications for Road and Bridge Works (IV Revision).

4. Arrangement for Traffic

During the period of construction, the arrangement of traffic shall be done accordingly, by providing proper diversions as per the directives of Engineer.

5. Method of Measurements

Granular sub-base shall be measured as per the section of finished work in position in m^3.

The protection of edges granular sub-base extended over the full formation as shown in the Drawing shall be considered incidental to the work of providing granular sub-base and as such not extra payment shall be made for such incidental works including diversions.

2.05 WMM (Wet Mix Macadam) Sub-Base / Base-250mm

A. Providing and laying WMM (wet mix macadam) Sub-base / base for required depth with black stone metal, size specified in detailed specification on sub base. Metal shall be mixed by approved mixing plant of suitable capacity having provision for controlled addition of water and forced / positive mixing arrangement like pug mill or pan type mixer of concrete batching plant, laying and spreading with mechanical spreader for required consolidated depth. Including rolling with 8 / 10 MT power roller to required slope and camber, etc. complete as per instruction of Engineer.

1. Scope

This work shall consist of laying and compacting clean, crushed, graded aggregate and granular material, premixed with water to a dense mass on a prepared sub-grade /sub-base / base or existing pavement as the case may be in accordance with the requirements of these specifications. The material shall be laid in one or more layers as necessary to lines, grades and cross-sections shown on the approved drawings or as directed by the Engineer .

The thickness of a single compacted Wet Mix Macadam layer shall not be less than 75mm. When vibrating or other approved types of compacting equipment are used, the compacted depth of a single layer of the sub-base course may be increased to 200 mm upon approval of the Engineer.

2. Materials specification

a. Aggregates

Physical requirements

Coarse aggregates shall be crushed stone. If crushed gravel / shingle are used, not less than 90 percent by weight of the gravel / shingle pieces retained on 5.75 mm sieve shall have at least two fractured faces. The aggregates shall conform to the physical requirements set forth in Table

Table : Physical Requirements of Coarse Aggregates for Wet Mix Macadam for Sub-Base / Base Courses

	Test	**Test Method**	**Requirements**
1.	*Los Angeles Abrasion value	IS : 2386 (Part-4)	40 percent (Max)
	OR		
	*Aggregate Impact value	IS: 2386 (Part-4) or IS : 5640	30 percent (Max)
2.	Combines Flakiness and Elongation Indices (Total)	IS : 2386 (Part-1)	30 percent (Max)

* Aggregate may satisfy requirements of either of the two tests.
If the water absorption value of the coarse aggregate is greater than 2 per cent, the soundness test shall be carried out on the material delivered to site as per IS: 2386 (Part-5)

Grading requirements:

The aggregates shall conform to the grading given in Table

Table: Grading Requirements of Aggregates for Wet Mix Macadam

IS Sieve Designation	**Per cent by weight passing the IS sieve**
53.00 mm	100
45.00 mm	95-100
26.50 mm	--
22.40 mm	60-80
11.20 mm	40-60
5.75 mm	25-40
2.36 mm	15-30
600.00 micron	8-22
75.00 micron	0-8

Materials finer than 425 micron shall have Plasticity Index (PI) not exceeding 6.
The final gradation approved within these limits shall be well graded from coarse to fine and shall not vary from the low limit on one sieve to the high limit on the adjacent sieve or vice versa.

Frequency of tests for Subgrade, GSB and WMM

Section	Type of Construction	Test	Spec. Limits	Frequency (min.)
1.4.1	Sub Grade	Sand content	-	2 tests / 3000 m^3
		Plasticity Index test	-	2 tests / 3000 m^3
		Density of Compacted Layer	97%	2 tests / 3000 m^3
		Deleterious content test	-	Once per source
		Moisture content test	-	1 /250 cum
		C.B.R. test	As specified in RFP	1 / 3000 cum
1.4.2	Granular sub base	Gradation	MORTH Table no.400.1, grading– I	1 /200 cum
		Atterberg Limit	PI - < 6%, LL - <25%	1 /200 cum
		Moisture Content Prior to compaction	+1%, -2% of the OMC	1 /250 cum
		Density of compacted layer	97%	1 /500 cum
		Water absorption of aggregate	2%, if water absorption more than 2% do soundness test as below	Initially one set of 3 representative specimen for each source of supply subsequently when warranted by changes in the quality of aggregates
		Soundness (Magnesium & Sodium Sulphate)	Max.12% Max.18%	Initially one set of 3 representative specimen for each source of supply subsequently when warranted by changes in the quality of aggregates
1.4.3	Wet Mix Macadam	Aggregate Impact value Los Angeles abrasion value	Max 30% Max 40%	
		Quality of Screening Material	LL max – 20%, PI – Max – 6%	Once per source
		Shape and Size	As per tech. spec.	Once per source
		Grading		1 test per 200 cum

3. Construction Specifications

a. Preparation of base

As per clause 405.3.1 MoSRT&H specification.

b. Provision of lateral confinement of aggregates

While constructing wet mix macadam, arrangement shall be made for the lateral confinement of wet mix. This shall be done by laying materials in adjoining shoulders along with that of wet mix macadam layer and following the sequence of operations described in Clause 407.5.1 of MoSRT&H Specification.

c. Preparation of mix:

Wet Mix Macadam shall be prepared in an approved mixing plant of suitable capacity having provision for controlled addition of water and forced / positive mixing arrangement like pugmill or pan type mixer of concrete batching plant.

Optimum moisture for mixing shall be determined in accordance with IS: 2720 (Part-8) after replacing the aggregate fraction retained on 22.4 mm sieve with material of 5.75 mm to 22.4 mm size. While adding water, due allowance should be made for evaporation losses. However, at the time of compaction, water in the wet mix should not vary from the optimum value by more than agreed limits. The mixed material should be uniformly wet and no segregation should be permitted.

d. Spreading of mix:

Immediately after mixing, the aggregates shall be spread uniformly and evenly upon the prepared sub grade / sub-base / base in requirement quantities. In no case should these be dumped in heaps directly on the area where these are to be laid nor shall their hauling over a partly completed stretch be permitted.

The mix may be spread either by a pavers finisher or motor grader. For portions where mechanical means cannot be used, manual means as approved by the Engineer shall be used. The motor grader shall be capable of spreading the material uniformly all over the surface. Its blade shall have hydraulic control suitable for initial adjustments and maintaining the same so as to achieve the specified slope and grade.

The paver finisher shall be self-propelled, having the following features:

Loading hoppers and suitable distribution mechanism.

The screed shall have tamping and vibrating arrangement for initial compaction to the layer as it is spread without rutting or otherwise marring the surface profile.

The paver shall be equipped with necessary control mechanism so as to ensure that the finished surface is free from blemishes.

The surface of the aggregate shall be carefully checked with templates and all high or low spots remedies by removing or adding aggregate as may be required. The layer may be tested by depth blocks during construction. No segregation of larger and fine particles should be allowed. The aggregates as spread should be of uniform gradation with no pockets of fine materials.

e. Compaction

After the mix has been laid to the required thickness, grade and cross fall / camber the same shall be uniformly compacted, to the full depth with suitable roller. If the thickness of single compacted layer does not exceed 100mm, a smooth wheel roller of 80 to 100 KN weight may be used. For a compacted single layer upto 200 mm, the compaction shall be done with the help of vibratory roller of minimum static weight of 80 to 100 KN or equivalent capacity roller. The speed of the roller shall not exceed 5 Km/hr

In portions having unidirectional cross fall / super elevation, rolling shall commence from the lower edge the progress gradually towards the upper edge. Thereafter, roller should progress parallel to the centre line of the road, uniformly over-lapping each preceding track by at least one third width until the entire surface has been rolled. Alternate trips of the roller shall be terminated in stops at least 1 m away from any preceding stop.

In portions in camber, rolling should begin at the edge with the roller running forward and backward until the edges have been firmly compacted. The roller shall then progress gradually towards the centre parallel to the centre line of the road uniformly overlapping each of the preceding tracks by at least one-third width until the entire surface has been rolled.

Any displacement occurring as a result of reversing of the direction of a roller or from any other cause shall be corrected at once as specified and/or removed and made good.

Along forms, kerbs, walls or other places not accessible to the roller, the mixture shall be thoroughly compacted with mechanical tampers or a plate compactor. Skin patching of an area without scarifying the surface to permit proper bonding of the added material shall not be permitted.

Rolling should not be done when the sub grade is soft or yielding or when it causes a wave-like motion in the sub-base/base course or sub grade. If irregularities develop during rolling which exceed 12 mm when tested with a 3 meter straight edge, the surface should be loosened and premixed material added or removed as required before rolling again so as to achieve a uniform surface conforming to the desired grade and cross fall. In no case should the use of unmixed material be permitted to make up the depressions.

Rolling shall be continued till the density achieved is at least 98 per cent of the maximum dry density for the material as determined by the method outlined in IS: 2720 (Part-8).

After completion, the surface of any finished layer shall be well-closed, free from movement under compaction equipment or any compaction planes, ridges, cracks and loose material. All loose, segregated or otherwise defective areas shall be made good to the full thickness of the layer and re-compacted.

f. Setting and drying

After final compaction of wet mix macadam course, the road shall be allowed to dry for 24 hours.

g. Opening to Traffic

Preferably no vehicular traffic of any kind should be allowed on the finished wet mix macadam surface till it has dried and the wearing course laid.

h. Surface Finish and Quality Control of Work

Surface evenness:

The surface finish of construction shall conform to the requirements of Clause 902 of MoSRT&H specification.

Quality control:

Control on the quality of materials and works shall be exercised by the Engineer in accordance with Section 900 of MoSRT&H specification.

i. Rectification of Surface Irregularity

Where the surface irregularity of the wet mix macadam course exceeds the permissible tolerances or where the course is otherwise defective due to sub grade soil getting mixed with the aggregates, the full thickness of the layer shall be scarified over the affected area, re-shaped with added premixed material or removed and replaced with fresh premixed material as applicable and re-compacted in accordance with Clause 406.3 of MoSRT&H specification. The area treated in the aforesaid manner shall not be less than 5 m long and 2 m wide. In no case shall depressions be filled up with unmixed and un-graded material or fines.

j. Arrangement for traffic

During the period of construction, arrangement of traffic shall be done as per Clause 112 of MoSRT&H specification.

4. Method of Measurements

Wet mix macadam shall be measured as finished work in position in cubic meters.

2.06 Tack Coat

A. Scope

This work shall consist of application of a single coat of low viscosity liquid bituminous material to an existing road surface preparatory to another bituminous construction over it.

B. Materials specification

1. Binder

The binder used for tack coat shall be a bituminous emulsion or cutback as specified in the Contract.

C. Construction Specifications

1. Preparation of base

The surface on which the tack coat is to be applied shall be cleaned of dust and any extraneous material before the application of the binder, by using a mechanical broom or any other approved equipment/method as specified by the Engineer.

2. Application of binder

Binder may be heated to the temperature appropriate to the grade of cutback used and approved by the Engineer and sprayed on the base at the rate specified in Table below. The normal range of spraying temperature for a bituminous emulsion shall be 20 ^{0}C -60^{0}C for a cutback 50^{0}C - 80^{0}C. If IRC-70/ MC-70 grade is used. It shall be the responsibility of the Contractor to carefully handle the inflammable bituminous cutback material so as to safeguard against any fire mishap. The binder shall be applied uniformly with the aid of either self-propelled or towed bitumen pressure sprayer with self-heating arrangement and spraying bar with nozzles having constant volume or pressure system, capable of spraying bitumen at specified rates and temperature so as to provide a uniformly unbroken spread of bitumen. Work should be planned so that no more than the necessary tack coat for the day's operation is placed on the surface. After application and prior to succeeding construction allow the tack coat to cure, without being disturbed, until the water/cutter has completely evaporated. As determined by the Engineer.

Table : Rate of Application of Tack Coat

Sr.	Type Surface	Quantity Of Liquid Bituminous Material In kg Per 10 Sq.M area
	Normal bituminous surfaces	2.0 to 2.5
	Dry and hungry bituminous surfaces	2.5 to 3.0
	Granular surfaces treated with primer	2.5 to 3.0
	Non bituminous surfaces	
(i)	Granular base (not primed)	3.5 to 4.0
(ii)	Cement concrete pavement	3.0 to 3.5

D. Quality control of Work

Control on the quality of materials and works shall be exercised by the Engineer in accordance with Section 900 of MoSRT&H Specifications for Road and Bridge Works (III Revision).

E. Measurement for Payment

Tack coat shall be measured in terms of surface area of application in square meters.

2.07 Dense Bituminous Macadam- DBM 85mm

A. Scope

This work shall consist of construction in a single course of 50 to 100 mm thick base / binder course to the following Specifications on a previously prepared base.

B. Materials specification

1. Bitumen

The bitumen shall be paving bitumen of Penetration Grade S65 or A 65 (60/70) as per Indian Standard Specifications for “Paving Bitumen” IS:73. In case of non-availability of bitumen of this grade, S90 (80/100) grade bitumen may be used with the approval of the Engineer. Guidance to selection of the grade of bitumen may be taken from Appendix 4 of MORT Specifications for Road and Bridge Works (III Revision).

2. Coarse aggregates

The coarse aggregates shall consist of crushed stone, crushed gravel / shingle or other stones. They shall be clean, strong, durable, of fairly cubical shape and free from disintegrated pieces, organic or other deleterious matter and adherent coating. The aggregates shall preferably be hydrophobic and of low porosity. If hydrophilic aggregates are to be used, the bitumen shall be treated with antis tripping agents of approved quality in suitable doses. The aggregates shall satisfy the physical requirements set forth in Table 13-10.

If crushed gravel / shingle is used, not less than 90 per cent by weight of the gravel / shingle pieces retained on 4.75 mm sieve shall have at least two fractured faces. The portion of the total aggregate passing 4.75 mm sieve shall have a sand equivalent value of not less than 50 when tested in accordance with the requirement of IS:2720 (Part-37).

The plasticity index of the fraction passing the 425 micron sieve shall not exceed 4.

Table : Physical Requirements of Aggregates For Dense Bituminous Macadam

Sr.	Test	Test method	Requirements
1.	Los Angeles Abrasion* value	IS:2386 (Part - 4)	40 per cent Maximum
2.	Aggregate Impact value*	IS:2386 (Part - 4)	30 per cent Maximum
3.	Flakiness and Elongation Indices (Total)	IS:2386 (Part - I)	30 per cent Maximum
4.	Coating and Stripping of Bitumen Aggregate Mixtures	AASHTO T 182	Minimum retained coating 95 per cent
5.	Soundness Loss with Sodium Sulphate Loss with Magnesium Sulphate	IS:2386 (Part - 5) 5 cycles 5 cycles	 12 per cent Maximum 18 per cent Maximum
6.	Water absorption	IS:2386 (Part - 3)	2 per cent Maximum

* Aggregates may satisfy requirements of either of the two tests.

3. Fine Aggregates

Fine aggregates shall be the fraction passing 2.36 mm sieve and retained on 75 micron sieve, consisting of crusher-run screening, gravel, and sand or a mixture of both. These shall be clean, hard, durable, uncoated, dry and free from any injurious, soft or flaky pieces and organic or other deleterious substances.

4. Filler

Filler shall consist of finely divided mineral matter such as rock dust, hydrated lime or cement as approved by the Engineer.

The filler shall be free from organic impurities and have a Plasticity Index not greater than 4. The Plasticity Index requirement shall not apply if filler is cement or lime. When the coarse aggregate is gravel, 2 per cent by mass of total aggregate of Portland cement or hydrated lime shall be added and the percentage of fine aggregate reduced accordingly. Cement or hydrated lime is not required when the gravel is limestone.

Table : The filler shall be graded within the following limits:

IS Sieve	Per cent passing by weight
600 micron	100
300 micron	95-100
75 micron	85-100

5. Aggregate gradation

The combined coarse and fine aggregates and filler (when used) shall produce a mixture of conform to the grading set forth in Table 8.12.3.

Table : Aggregate Gradation for Dense Bituminous Macadam

Sieve Designation	**Percentage passing the sieve by weight**
37.5 mm	100
26.5 mm	90-100
13.2 mm	56-80
4.75 mm	29-59
2.36 mm	19-45
300 micron	5-17
75 micron	1-7

The aggregate mix, as used in work, shall not vary from the low limit on one sieve to the high limit on the adjacent sieve but shall be well graded.

C. Mix Design

1. Requirement of mix

Apart from conformity with grading and quality requirements of individual ingredients, the mix shall meet the requirements set out in Table 8.12.4.

Table : Requirements of Dense Bituminous Macadam Mix

Sr.	**Description**	**Requirements**
1.	Marshall Stability (ASTM Designation D-1559) determined on Marshall specimens compacted by 75 compaction blows on each end	820 kg (1800 lb)
2.	Marshall flow (mm)	2-4
3.	Per cent Air voids	3-5
4.	Minimum voids in mineral aggregate (VMA)	10 per cent - 12 per cent
5.	Per cent voids in mineral aggregates filled by bitumen (VFB)	65 - 75
6.	Binder content per cent by weight of total mix	Not less than 4.0 per cent

2. Binder content

The binder content shall be so fixed as to achieve the requirements of the mix set out in Table 8-12. Marshall method for arriving at the binder content shall be adopted, replacing the aggregates retained on 26.5 mm sieve by the aggregates passing 26.5 mm sieve and retained on 22.4 mm sieve.

3. Job mix formula

The Contractor shall intimate to the Engineer in writing, at least 20 days before the start of the work, the job mix formula proposed to be used by him for the work and shall give the following details:

- Source and location of all materials

- Proportions of all materials expressed as follows where each is applicable:
- Binder, as percentage by weight of total mix;
- Coarse aggregate/Fine aggregate/Mineral filler as percentage by weight of total aggregate including mineral filler;
- A single definite percentage passing each sieve for the mixed aggregate;
- The results of tests enumerated in Table 13-12 as obtained by the Contractor;
- Test results of physical characteristics of aggregates to be used;
- Mixing temperature and compacting temperature.

While working out the job mix formula, the Contractor shall ensure that it is based on a correct and truly representative sample of the materials that will actually be used in the work and that the mix and its different ingredients satisfy the physical and strength requirements of these Specifications.

Approval of the job mix formula shall be based on independent testing by the Engineer for which samples of all ingredients of the mix shall be furnished by the Contractors required by the former.

The approved job mix formula shall remain effective unless and until modified by the Engineer. Should a change in the source of materials be proposed, a new job mix formula shall be established and got approved from the Engineer before actually using the materials.

4. Permissible variation from job mix formula

It shall be the responsibility of the Contractor to produce a uniform mix conforming to the approved job mix formula subject to the permissible various of the individual percentages of the various ingredients in the actual mix from the job mix formula to be used within the limits as specified in Table. These variations are intended to apply to individual specimens taken for quality control tests vide Section 900 of MoSRT&H Specifications for Road and Bridge Works (III Revision).

Table : Permissible Variations from the Job Mix Formula

Sr.	Description of Ingredients	Permissible variation by weight of total mix-in per cent
1.	Aggregate passing 13.2 mm sieve and larger sieves	± 8
2.	Aggregate passing 11.2 mm sieve and 5.6 mm sieve	± 7
3.	Aggregate passing 2.80 mm sieve and 1.40 mm sieve	± 6
4.	Aggregate passing 710 micron sieve and 1.35 mm sieve	± 5
5.	Aggregate passing 180 micron sieve	± 4
6.	Aggregate passing 90 micron sieve	± 2
7.	Binder	± 0.3
8.	Mixing temperature	± 10° C

D. Construction Specifications

1. Weather and Seasonal Limitations

The work of laying shall not be taken up during rainy or foggy weather or when the base course is damp or wet, or during dust storm or when the atmospheric temperature in shade is 10^0C or less.

2. Preparation of base

The base on which Dense Bituminous Macadam is to be laid shall be prepared, shaped and conditioned to the specified lines, grades and cross sections in accordance with or as directed by the Engineer . The surface shall be thoroughly swept clean free from dust and foreign matter using mechanical broom and dust removed or blown off by compressed air. In portions where mechanical means cannot reach, other approved method shall be used. A priming coat where needed, shall be applied in accordance with above or as directed by the Engineer.

3. Tack coat

A tack coat over the base shall be applied as per Section 2.73.

4. Preparation of Mix

Dense Bituminous macadam mix shall be prepared in a hot mix plant of adequate capacity and capable of yielding a mix of proper and uniform quality with thoroughly coated aggregates. Hot mix plant shall be of suitable capacity preferably of batch mix type. Total system for crushing of stone aggregates and feeding of aggregate fractions in required proportions to achieve the desired mix, deployed by the Contractor must be capable of meeting the overall Specification requirements under stringent quality control. The plant shall have the following essential features:

A - General

- The plant shall have coordinated set of essential units capable of producing uniform mix as per the job mix formula.
- Cold aggregate feed system with minimum 4 bins having belt conveyor arrangement for initial proportioning of aggregates from each bin in the required quantities. In order to have free flow of fines from the bin, it is advisable to have vibrator fitted on bin to intermittently shake it,.
- Belt conveyors below each bin should have variable speed drive motors. There should be electronic load sensor on the main conveyer for measuring the flow of aggregates.
- Dryer unit with burner capable of heating the aggregate to the required temperature without any visible unburnt fuel or carbon residue on the aggregate and reducing the moisture content of the aggregate to the specified minimum.
- The plant shall be fitted with suitable type of thermometric instruments at appropriate places so as to indicate or record/register the temperature of heated aggregate, bitumen and mix.
- Bitumen supply unit capable of heating, measuring/metering and spraying of bitumen at specified temperature with automatic synchronisation of bitumen and aggregate feed in the required proportion.

- A filter system suitable to receive bagged or bulk supply of filter material and its incorporation to the mix in the correct quantity wherever required.
- A suitable built-in dust control system for the dryer to contain/recycle permissible fines into the mix. It should be capable of preventing the exhaust of fine dust into atmosphere for environmental control.
- The plant should have centralized control panel/cabin capable of presetting, controlling/synchronizing all operations starting from feeding of cold aggregates to the discharge of the hot mix to ensure proper quality of mix. It should have indicators for any malfunctioning in the operation.
- Every hot mix plant should be equipped with siren or horn so that the operator may use the same before starting the plant every time in the interest of safety of staff.

B - For Batch Type Plant

- Gradation control unit having minimum four deck vibratory screens for accurate sizing of hot aggregate and storing them in separate bins. This unit should be fully covered to reduce the maintenance cost and for better environmental conditions.
- Proper arrangement for accurate weighing of each size of hot aggregate from the control panel before mixing.
- Paddle mixer unit shall be capable of producing a homogeneous mix with uniform coating of all particles of the mineral aggregate with binder.

C - For Continuous Type Plant

- Gradation control unit having vibratory screens for accurate sizing of hot aggregate and storing them in separate bins. This unit should be fully covered to reduce the maintenance cost and for better environment condition.
- There should be appropriate arrangements for regulating and volumetric control of the flow of hot aggregate from each bin to achieve the required proportioning.
- Paddle mixer unit shall be capable of producing a homogeneous mix with uniform coating of all particles of the mineral aggregate with binder.

D - For Drum Mix Plant

- It is a prerequisite that only properly screened and graded materials are fed to the bins. If required, vibratory screening unit shall be installed at the plant site to ensure the same.
- A primary 4- deck vibratory screening unit shall be installed before the multiple bin cold feed system for screening the aggregates and grading the same.
- Belt conveyers below each bin should have variable speed drive motors. There should be electronic load sensor on the main conveyor for measuring the flow of aggregate.

- There should be arrangement to measure moisture content of the aggregate(s) to that moisture correction may be applied for working out requirements of binder and filler.

The temperature of binder at the time of mixing shall be in the range of 150^0C to 163^0C and that of the aggregate in the range of 155^0C - 163^0C. Provided that the difference in temperature between the binder and aggregate at no time exceeds 14^0C.

Mixing shall be thorough to ensure that a homogeneous mixture is obtained in which all particles of the aggregates are coated uniformly, and the discharge temperature of mix shall be between 130^0C to 160^0C.

The mixture shall be transported from the mixing plant to the point of use in suitable tipper vehicles. The vehicles employed for transport shall be clean and be covered in transit if so directed by the Engineer. Any tipper causing excessive segregation of materials by its spring suspension or other contributing factors or that which shows undue delay shall be removed from the work until such conditions are corrected.

5. Spreading

The mix transported from the hot mix plant to the site shall be spread by means of a self-propelled paver with suitable screeds capable of spreading, tamping and finishing the mix to specified grade, lines and cross-section. Paver Finisher shall have the essential features as spelt out in the following paragraphs.

However, in restricted locations and in narrow widths where the available equipment cannot be operated in the opinion of the Engineer, he may permit manual laying of the mix. Similarly for smaller jobs, mechanical paver may be used with the approval of the Engineer.

- Loading hoppers and suitable distributing mechanism.
- All drives having hydrostatic drive/control
- The machine shall have a hydraulically extendable screed for appropriate width requirements.
- The screed shall have tamping and vibrating arrangement for initial compaction to the layer as it is spread without rutting or otherwise marring the surface. It shall have adjustable amplitude and variable frequency.
- The paver shall be equipped with necessary control mechanism so as to ensure that the finished surface is free from surface blemishes.
- The paver shall be fitted with an electronic sensing device for automatic levelling and profile control within specified tolerances.
- The screed shall have the internal heating arrangement.
- The paver shall be capable of laying either 2.5 to 4.0 m width or 4.0 to 7.0 m width as stipulated in the Contract.
- The paver shall be so designed as to eliminate skidding/slippage of the tyres during operation

The temperature of mix at the time of laying shall be in the range of 120^0C - 160^0C.

Mixes with a temperature of less than 120^0C shall not be put into paver spreader. Longitudinal joints and edges shall be constructed true to the delineating lines parallel to the centre line of the road. Longitudinal and transverse joints shall be offset by at least 250 mm from those in the lower courses and the joint on the top most layer shall not be allowed to fall within the wheel path. All transverse joints shall be cut vertically to the full thickness of the previously laid mix with asphalt cutter and the surface painted with hot bitumen before placing fresh material. Longitudinal joints shall be preferably hot joints. Cold longitudinal joints shall be properly heated with joint heater to attain a suitable temperature of about 80^0C before laying of adjacent material.

6. Rolling

After spreading the mix by paver, it shall be thoroughly compacted by rolling with a set of rollers moving at a speed not more than 5 km/h, immediately following close to the paver. Generally the initial or breakdown rolling shall be done with 80-100 kN static weight smooth-wheeled roller. The intermediate rolling shall be done with 80-100 kN static weight vibratory roller or with a pneumatic tyred roller of 150-250 kN weight having a tyre pressure of at least 0.7 MPa. The finish rolling shall be done with 60-80 kN weight smooth wheeled tandem roller. All the compaction operations, i.e., breakdown rolling and intermediate rolling can be accomplished by using vibratory tandem roller of 80-100 kN static weight. During initial breakdown rolling and finish rolling, no vibratory compaction shall be resorted to. The exact pattern of rolling shall be established after trial compaction as approved by the Engineer.

Any displacement occurring as a result of reversing of the direction of a roller or for many other cause shall be corrected at once as specified and/or removed and made good. The rollers shall not be permitted to stand on pavement which has not been fully compacted and where temperature is still more than 70^0C. Necessary precautions shall be taken to prevent dropping of oil, grease, petrol or other foreign matter on the pavement either when the rollers are operating or standing.

The wheels of roller shall be kept moist to prevent the mix from adhering to them. But in no case shall fuel/lubricating oil be used for this purpose nor excessive water poured on the wheels. Rolling shall commence longitudinally from edges and proceed towards the centre, except that on the elevated and unidirectional cambered portions, it shall progress from the lower to upper edge parallel to the centre line of the pavement. The roller shall proceed on the fresh material with rear or fixed wheel leading so as to minimize the pushing of the mix and each pass of the roller shall overlap the preceding one by half the width of the rear wheel.

Rolling shall be continued till the density achieved is at least 98 per cent of that of laboratory Marshall specimen and all roller marks are eliminated. Skin patching of an area that has been rolled will not be permitted. Rolling operations shall be completed in all respects before the temperature of the mix falls below 100^oC.

E. Opening to Traffic

Traffic may be allowed after completion of the final rolling when the mix has cooled down to the surrounding temperature. The Dense Bituminous Macadam shall be provided with an appropriate wearing course as early as possible prior to regular opening to normal traffic and/or impending rain.

F. Surface Finish and Quality Control of Work

The surface finish of construction shall conform to the requirements of Section 902 of MORT Specifications for Road and Bridge Works (III Revision).
Control on the quality of materials and works shall be exercised by the Engineer in accordance with Section 900 of MORT & H Specifications for Road and Bridge Works (III Revision)

G. Method of Measurements

Dense Bituminous Macadam shall be measured as finished work in m^3 .

2.08 Bituminous Concrete 40 mm

A. Scope

This work shall consist of constructing in a single layer, bituminous concrete (asphaltic concrete) of thickness 25 - 100 mm on previously prepared bituminous course to the requirements of these Specifications.

B. Materials

1. Bitumen

Same as per above Dense Bituminous Macadam

2. Coarse aggregates

The Stone Polishing Value as measured by relevant standard, codes and practices shall not be less than 55. The aggregates shall satisfy the physical requirements as given in table except that the maximum value for the water absorption should be 1 per cent.

3. Aggregates gradation

The mineral aggregates, including mineral filler shall be so graded or combined as to conform to the grading set forth in table.

Table : Aggregates Gradation For Bituminous Concrete

IS Sieve Designation	Per cent passing the sieve by weight
26.5 mm	100
19 mm	90-100
9.5 mm	56-80
4.75 mm	35-65
2.36 mm	23-49
300 micron	5-19
75 micron	2-8

C. Mix Design

1. Requirement of mix

Apart from conformity with the grading and quality requirements of individual ingredients, the mix shall meet the requirements set forth in Table given below.

Table : Requirements of Bituminous Concrete Mix

Sr.	Description	Requirements
1.	Marshall stability (ASTM Designation : D-1559) determined on Marshall specimens compacted by 75 compaction blows on each end	820 kg (1800 lb) Minimum
2.	Marshall flow (mm)	2-4
3.	Per cent air voids in mix	3-5
4.	Per cent voids in mineral aggregate (VMA)	Minimum 11-13 per cent
5.	Per cent voids in mineral aggregates filled by bitumen (VFB)	65-75
6.	Binder content, per cent by weight of total mix	Minimum 4.5
7.	Water Sensitivity (ASTM D1075) Loss of stability on immersion in water at 60oC	Min. 75 per cent retained strength
8.	Swell Test (Asphalt Instt. MS-2, No. 2)	1.5 per cent Max.

2. Binder content

The binder content shall be so fixed as to achieve the requirements of the mix set forth in Table 8.15. Marshall method for arriving at the binder content shall be adopted.

3. Job mix formula

Section 2.75 shall apply except that the requirement of Bituminous Concrete mix shall be as per table.

4. Permissible variations from the job mix formula

The Contractor shall have the responsibility of ensuring proper proportioning of materials in accordance with the approved job mix formula and producing a uniform mix. The permissible variations of individual percentages of various ingredients in the actual mix from the job mix formula may be within the limits as specified in Table. These variations are intended to apply to individual specimens taken for quality control tests vide Section 900 of MORT specifications for Road and Bridge Works (III Revision).

D. Construction Specifications

1. Weather and seasonal limitations:

As per above specs shall apply.

2. Preparation of base

The base on which bituminous concrete is to be laid shall be prepared, shaped and conditioned to the specified levels, grade and cross fall (camber) in accordance with Section 2.75 or as directed by the Engineer . The surface shall be thoroughly swept clean free from dust and foreign matter using mechanical broom and dust removed by mechanical means or blown off by compressed air. In portions where mechanical means cannot reach, other approved method shall be used.

3. Tack coat

A tack coat complying as mentioned in section 2.73 shall be applied over the base.

4. Preparation of mix

   Section 2.74.4 shall apply.

5. Spreading

   As per 2.74.4.5.

6. Rolling

   As per 2.74.4.6

E. Opening to Traffic

Traffic may be allowed immediately after completion of the final rolling when the mix has cooled down to the surrounding temperature.

1. Surface Finish and Quality Control of Work

   The surface finish of construction shall conform to the requirements of Section 902 of MoSRT&H Specifications for Road and Bridge Works (IV Revision).

   Control on the quality of materials and works shall be exercised by the Engineer in accordance with Section 900 of MORT Specifications for Road and Bridge Works (IV Revision).

F. Method of Measurements

Bituminous concrete shall be measured as finished work in m^3, or as specified in the relevant BOQ Item.

END OF SECTION 02750.

SECTION 02800 ANTITERMITE TREATMENT

PART 1 -GENERAL

1.01 Reference:

A. Section 02000 applies to and governs the work of this Section.

1.02 Work Included:

A. Provide labour, materials and other services to set up a chemical barrier against attack by termites while the buildings and other structures are under construction.

B. Uniform distribution and proper penetration of treating solution to foundations, walls, trenching for interconnecting piping, rising mains, bypasses and electrical conduits, basements, plinths, manholes and miscellaneous chambers.

C. The Drawings, Datasheets and Specifications are intended to set the acceptable minimum standard.

1.03 Related Work:

A. The following related work is covered elsewhere in the Contract Documents:

1.	Section 02000	-	Site Preparation
2.	Section 02221	-	Backfilling and Filling
3.	Section 02220	-	Excavation
4.	Division 3	-	Concrete
5.	Division 4	-	Masonry

1.04 Alternatives:

A. Refer to Section 01002 for requirements pertaining to acceptance of alternative equipment/ material.

1.05 Submittals:

A. Submit method of treatment proposed to be adopted for the approval of the Engineer in accordance with Section 01007 and AS-BUILT drawings as per Section 01016.

B. Upon completion of this work, submit a Pest Management Report, identifying target pest, type of operation, brand name and manufacturer of pesticide, formulation, concentration and rate of application used. Maintain daily records using Pest Management Maintenance Record and submit copies of records when requested by the Engineer.

C. Before commencing works, provide to the Engineer for approval, samples of chemicals from a reputable firm recommended by the Indian Pest Control Association (IPCA).

1.06 Codes and Standards:

A. The following applicable standards established by the Bureau of Indian Standards govern the materials and workmanship for the work under this Section.

1	IS: 6313 (Part I to III)	Code of Practice of Anti Termite Measures in Buildings - Pre-constructional Chemical Treatment Measures
2	IS: 3385	Code of Practice for Measurement of Civil Engineering Works

B. Where provisions of the pertinent codes and standards conflict with these Specifications and Drawings or with each other comply with the more stringent provision

C. Use the latest issue of Standards.

PART 2 - PRODUCTS

2.01 General:

A. Provide the following chemicals conforming to relevant Indian Standards in water emulsion.

	Chemicals	Concentration by Weight Percentage
1	Chlorpyrifos Emulsifiable(IS: 8944 – 1978)	1.0
2	Heptachlor Emulsifiable Concentrate (IS: 6439 – 1978)	0.5
3	Chlordane Emulsifiable Concentrate (IS: 2682 – 1984)	1.0

B. Delivery Storage and Handling

1. Pesticides shall be delivered to the site in sealed and labelled containers in good condition as supplied by the manufacturer or formulator. The pesticides shall be stored, handled and used in accordance with manufacturer's instructions. Labels shall bear evidence of registration as per the IS or appropriate regulations.

C. Safety Requirements

1. Formulate, treat and dispose of termiticides and their containers in accordance with the manufacturer's directions. Draw water for formulating only from sites approved by the Engineer and fit the filling hose with a backflow preventer meeting local plumbing codes and standards. The filling operation shall be under the direct and continuous observation of a Contractor's representative to prevent overflow. Secure pesticides and related materials under lock and key when unattended. Ensure that proper protective clothing and equipment are worn and used during all phases of termiticide application. Dispose of used pesticide containers outside the BMC property in accordance with applicable legislation.

2.02 Approved Manufacturers /Suppliers:

A. M/s. Pest Control Corporation of India

B. Or equivalent as approved

PART 3 - EXECUTION

3.01 General:

A. Work shall be executed as specified in IS 6313 Part-II and as per approved specification of the applicable agencies.

B. Ensure that there is uniform distribution and proper penetration of treating solution to the satisfaction of the Engineer.

C. Soil treatment shall not be done when it is raining or when the soil is wet with rain or subsoil water. Once formed, the treated soil barrier shall not be disturbed.

3.02 Treatment of Column Pits, Wall Trenches and Basement Excavations:

A. In case of normal load bearing structures, column pits, wall trenches and basements, the treatment shall be at 5 l/m^2 of surface area of the bottom and sides to a height of at least 300 mm. After the foundation work, the sides shall be treated at 7.5 l/m^2 of vertical surface of substructure on each side. After the earth filling is completed, treatment shall be by rodding the earth at 150 mm centres close to the wall surface and spraying the chemical at a rate of 7.5 l/m^2.

B. In the case of framed structures, the treatment shall start at a depth of 500 mm below ground level. From this depth the backfill around the columns, beams and RCC basement walls shall be treated at a rate of 7.5 l/m^2 for the vertical surface and at 5 l/m^2 for horizontal surfaces at the bottom of trenches/pits.

C. Treatment of Top Surface of Plinth Filling

1. The top surface of filled earth within plinth walls shall be treated with chemical emulsion at the rate of 5 l/m^2 of the surface area before sub-base to floor is laid. If filled earth has been well rammed and the surface does not allow the emulsion to seep through, holes up to 50 to 75mm deep at 150 mm centres both ways shall be made with crow bars on the surface to facilitate saturation of the soil with the emulsion.

D. Treatment of Soil Surrounding Pipes and Conduits

1. Special care shall be taken at the points where pipes and conduits enter the building and the soil shall be treated for a distance of 150 mm and a depth of 75 mm at the point where they enter the building.

E. Treatment of Expansion Joints

1. The soil beneath expansion joints shall be supplemented by treating through the expansion joint after sub-grade has been laid at the rate of 2 l/m length of expansion joint.

F. Treatment at Junction of the Wall and the Floor

1. Special care shall be taken to establish continuity of the vertical chemical barrier on the inner wall surfaces from the finished ground level (or from level where the treatment has stopped) up to the level of the filled earth surface. To achieved this, a small channel 30 x 30 mm shall be made at all the junctions of wall/column with the floor (before laying sub-grade) and rod holes made in the channel up to the finished ground level at 150 mm spacings and the iron rod moved backward and forward to break the earth and the chemical emulsion shall be poured along the channel at 7.5 l/m^2 of the vertical wall/column surfaces to soak the soil right up to the bottom. The soil shall be tamped back into place after this operation.

3.03 Acceptance Criteria

A. Provide a 10 year service guarantee in writing supplemented by a separate and unilateral guarantee from the specialized agency for the job to keep the building free of termites for the specified period.

3.04 Treatment Application

A. The Contractor shall apply termiticide to the soil material which will be covered by or lie immediately adjacent to the buildings and structures to provide a protective barrier against subterranean termites.

B. The termiticide shall be applied as a coarse spray and in such manner as to provide uniform distribution onto the soil surface. This treatment shall be applied prior to placement of a vapour barrier or waterproof membrane and prior to concrete pouring. Where treated soil or fill material is not to be covered with a vapour barrier or waterproof membrane, the Contractor shall exercise adequate precautions to prevent its disturbance.

C. The chemical emulsion will be applied uniformly by sprayers at the prescribed rates as detailed in all the stages of the treatment.

3.05 Warranty

A. Provide a three-year written warranty against infestations or re-infestations by termites of the buildings or building additions constructed under this Contract. Perform annual inspections of the building(s) or building addition(s). If live termite infestation or termite damage is discovered during the warranty period, and the soil and building conditions have not been altered in the interim: the Contractor shall:

1. Retreat the soil and perform other treatment as may be necessary for elimination of termite infestation.
2. Repair damage caused by termite infestation; and
3. Re-inspect the building approximately 180 days after the re-treatment.

END OF SECTION 02800.

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SECTION 03000 CONCRETE

PART 1 -GENERAL

1.01 Governing Conditions:

A. The General Conditions, Particular Conditions, Contract Forms, Instruction to Contractor and the requirements of Division 1 herein before specified, in addition to any and all Addenda, apply to and govern each Section of this Division.

B. This Section covers the general requirements for this Division and shall be read in conjunction with other Sections in this Division.

C. This Section governs the work of all other Sections in this Division.

1.02 Work Included:

A. Provide labour, material and equipment necessary to perform concrete work as indicated on the Drawings or specified herein, including but not necessarily limited to the following:

1. Formwork and falsework
2. Steel reinforcement
3. Spacer covers
4. Waterstops
5. Pre-cast Concrete
6. Cast-in-place concrete
7. Curing and finishing
8. Installation of inserts, anchors, cover blocks, spacers etc
9. Keys and recesses
10. Concrete topping and benching
11. Concrete bases for equipment and tanks.

B. The Drawings, Datasheets and Specifications are intended to set the acceptable minimum standard.

1.03 Co-ordination:

A. Co-ordinate with the work of other Divisions before installing work included in this Division. If work is installed without co-ordination with other works, the Engineer may direct that such work be removed, relocated and/or modified as necessary. Comply promptly with the Engineer's requests. Complete any correction and/or additional work, as directed by the Engineers at no additional cost to the BMC.

B. For coordination requirements refer to Section 01003.

1.04 Submittals:

A. Submit shop drawings / product data/ documents for concrete work as required, not limited to following list, in accordance with Section 01007- submittals.

1. Deviations to technical specification
2. Concrete layout drawings and concrete detail drawings
3. Reinforcement detail drawings
4. Reinforcement bar drawings, bending schedules and bar lists

5. Details of formwork and construction joints including shop drawings and design calculations
6. Cement and aggregate test reports
7. Concrete mix design
8. Concrete test report by BMC approved testing laboratory.

B. Neatly assemble and submit test reports and AS BUILT drawings as per Section 01700- Construction Contract Close Out.

1.05 Codes and Standards:

A. The following applicable standards established by the Bureau of Indian standards govern the materials and workmanship for the work under this Division.

1	IS 456	Code of practice for plain and reinforced concrete.
2	IS 457	Code of practice for general construction of plain and Reinforced concrete for dams and other massive structures
3	IS432(Part I)	Code of practice for mild steel or medium tensile steel bars for concrete or latest version reinforcement.
4	IS 1786	Cold twisted steel bars for concrete reinforcement.
5	IS 1566	Code of practice for fabric for concrete reinforcement, hard drawn steel or latest version wire welded wire mesh.
6	IS 516	Code of practice for method of test for strength of concrete
7	IS 2062	Code of practice for steel for general structural purpose
8	IS 10262	Code of practice for recommended guidelines for concrete mix design
9	IS 3370	Code of practice for concrete structures for the storage of liquids
10	IS 2751	Recommended practice for welding of mild steel plain and deformed bars for reinforced construction.
11	IS 2502	Code of practice for bending and fixing of bars for concrete reinforcement.
12	IS 2571	Code of practice for laying in-situ cement concrete flooring.
13	IS 9103	Admixtures
14	IS 4926	Code of practice for ready mix concrete.

B. Where provisions of pertinent codes and standards conflict with these Specifications and Drawings or each other, comply with the more stringent provisions.

C. Use the latest issue of Standards.

PART 2 - PRODUCTS

2.01 General:

A. Comply with product requirements outlined in the individual Sections and as specified on the Drawings.

B. Select all other materials, not specifically described but required for proper completion of the work of this Division.

2.02 Cast-In-Place Concrete:

A. Concrete Mixes and admixtures: Refer to Section 03300.

2.03 Fire Protection for materials and equipments:

A. All materials and equipments specified under this division shall be provided in accordance with NFPA 820 and the NEC-Area Electrical Classification details provided on the drawings.

B. Zones indicated in the drawings refers to divisions specified in NFPA 820

PART 3 - EXECUTION

3.01 General:

A. Comply with execution requirements outlined in the individual Sections and as specified herein.

3.02 Special Construction:

A. Water-tightness:

1. Base slabs and exterior walls below grade to be made watertight to prevent any groundwater seepage or leakage of water from inside to outside. Prior to backfilling perform a leakage test to water-retaining structures as specified in IS 3370. Repair all cracks which exhibit leakage to the satisfaction of the Engineer.

3.03 Field Quality Control:

A. Cube moulds in required quantity

B. Cube testing machine of 100 t capacity

C. Sieves for gravel and sand

D. Measuring glass for silt content

E. Laboratory oven

F. Slump cone with base plate and rod.

3.04 Schedule of Concrete Finishes:

A. Refer to Section 03300 for finish types.

END OF SECTION 03000.

SECTION 03100 FORMWORK

PART 1 -GENERAL

1.01 Reference:

A. Section 03000 applies to and governs the work of this Section.

1.02 Work Included:

A. Design, supply and install required formwork for the construction of the structure.

B. Remove formwork after completion as specified.

C. Fixing of insert plates, pipes, pipe sleeves, bolts etc.

1.03 Related Work:

A. The following related work is covered elsewhere in the contract documents.

1.	Division 2	-	Site Work
2.	Section 03200	-	Reinforcement
3.	Section 03300	-	Cast-In-Place (In-Situ) Concrete

1.04 Alternatives:

A. Refer to Section 01030 for requirements pertaining to acceptance of alternatives.

1.05 Submittals:

A. Submit shop drawings, product data, and design calculations for vertical walls, roofs etc, and documents as specified in Section 03000 in accordance with Section 01300.

B. Provide, before commencement of fabrication, details of the materials and means proposed to adopt to obtain the required special finishes.

1.06 Codes and Standards:

A. The following applicable standards established by the Bureau of Indian Standards govern the materials and workmanship for the work under this Section.

1	IS 4990	Specification for plywood for concrete shuttering work.
2	IS 800	Code of practice for use of structural steel in general building construction.
3	IS 806	Code of practice for use of steel tube in general building construction.
4	ACI 301	Specification for Form Finish

B. Where provisions of the pertinent codes and standards conflict with these Specifications and Drawings or with each other comply with the more stringent provisions.

C. Use the latest issue of Standards.

PART 2 - PRODUCTS

2.01 Materials:

A. All formwork shall be constructed of timber, sheet metal, plywood or other approved material, capable of providing the type of finish specified. All materials used shall be dimensionally stable on exposure to the prevailing weather and conditions.

2.02 Form Coating:

A. This shall be a non-grain raising and non-staining resin type coating or other suitable non-staining oil for formwork which will not leave residual matter on the surface of the concrete or adversely effect the bonding to concrete of paint, plaster, mortar, protective coatings, water proofings or other applied materials. The coatings shall not contain any mineral oils, paraffin, waxes or other non-drying ingredients, nor in the case of surfaces in contact with potable water, any toxic ingredients of any type whatsoever.

2.03 Metal Form Ties:

A. These shall be pre-fabricated rod, snap-off or threaded internal disconnecting type of adequate tensile strength to withstand all imposed loads. Ties shall leave no metal within 38 mm of concrete surface after removal. Snap-off type ties shall have integral washer spreaders of such diameters to fully close tie-holes in forms. Ties shall be fitted with an integral water-stop which remains in place in water retaining structures.

2.04 Metal Form

A. Metal formwork shall be true to detail in condition, clean, free from dents, bends, rust and oil or other defects likely to impair the specified finish.

2.05 Circular Column Forms:

A. Forms for circular columns shall be metal tubes of materials as described for metal forms, fibre glass reinforced plastic or other approved material.

2.06 Form Joint Sealers:

A. Effective precautions shall be taken to ensure that joints between form panels are sufficiently water tight to prevent honey combing resulting from the escape of mortar during the placing and vibration of concrete. The joints shall be sealed with resilient foam rubber strips, non-hardening plastic type caulking compound free from oil or other such material or such other compound as may be approved by the Engineer. Form tie holes shall be plugged with plastic caulking compound, tight fitting rubber plugs or equal.

2.07 Moulds:

A. Moulds as required for grooves, drips, rebates, profiles, chamfers and other similar items shown in the drawings shall be of a smooth-milled approved timber or standard extruded polymer plaster units of the required shapes.

B. Metal, plywood or forms of other approved material shall be used to provide a smooth finish. Special concrete finishes and requirements are described in Section 03300, if required in the works comprising this Contract. Column forms should be of materials specified above for a smooth finish.

C. Plywood or board forms of lesser quality may be used to provide rough finishes.

PART 3 - EXECUTION

3.01 Concrete Form Finish Types:

A. All concrete surfaces above and below grade shall have a smooth form finish in accordance with ACI 301 Surface Finish 3.0 (SF-3):

1. Patch voids larger than 1/2 inch wide or 1/2 inch deep.
2. Remove projections larger than 1/8 inch.
3. Patch tie holes.
4. Provide surface tolerance Class A in accordance with ACI 117.

B. For slab finishes refer to section 03300.

3.02 Shoring and Formwork:

A. Shoring and formwork to be designed to distribute loads safely over the base area on which the shoring is erected. If the ground on which shoring is to be erected is loose, or may become loose when cleaning shuttering with water, adequate precaution must be taken to compact soil. Ensure stability of the formwork.

3.03 Alignment and Camber:

A. All forms to be constructed to produce the required lines, grades and camber as required, in the finished structure. The tolerance on line and level shall not exceed 3 mm. In the absence of any specific camber, the forms for soffits of beams to be constructed to provide an upward camber of 6 mm for every 3 metres of clear span.

B. Jacks, wedges or similar approved means shall be used to induce the required camber in the forms and to correct any settlement which may occur either before or during the placing of concrete.

C. Inspection:

1. Prior to commencing work of this Section, carefully inspect the installed work of others and verify that such work is complete to the point where this installation may properly commence.

D. Discrepancies:

1. In the event of any discrepancy, immediately notify Engineer.
2. Do not proceed with installation in areas of discrepancy until all such discrepancies have been fully resolved.

3.04 Construction:

A. Formwork shall be constructed to the exact shapes, sizes, lines and dimensions making provisions for openings, offsets, keyways, recesses, mouldings reglets, chamfers, blocking, joint screeds, bulkheads, anchorages and other required features.

B. Forms to be easily removable without hammering or damage to the concrete surfaces and be constructed to prevent sagging, leakage of mortar or displacement during or after pouring concrete.

C. Forms to be coated with specified materials prior to placing and tying reinforcement with precautions taken to prevent the coating from contaminating the reinforcement.

D. Temporary openings shall be provided in wall and column forms for inspection and cleaning. All inner surfaces of forms shall be cleaned before concrete is poured.

E. Relents and rebates to receive flashing, frames and other equipment shall be properly formed. Dimensions, details and precise positions of all such relents and rebates shall be ascertained from the suppliers of the flashings, frames or equipment, if supplied under a separate contract.

F. Form windows shall be provided as ordered or found necessary to provide access for placement and vibration of concrete. The windows shall be adequately sized to admit

tremmies, chutes and vibrators and shall be spaced at 2 metre intervals. The windows shall be firmly closed and braced before placing concrete at higher levels.

G. Joints between forms shall be sealed with an approved compound as specified. Unless tie holes in the forms are fully sealed by form tie spreaders, leakage of mortar from around the ties shall be prevented by sealing as specified.

H. Chamfer all exposed edges and corners 20 mm x 20 mm, unless otherwise detailed on the Drawings.

I. Arrange internal form ties so that when forms are removed, no metal is within 38 mm of any exposed surface.

J. Use outside forms as well as inside forms on all walls.

K. False work

1. Erect false work in accordance with the approved shop drawings.
2. Use hardwood wedges or screw jacks to adjust forms to the proper height to correct any settlement before or during the placing operation.
3. Set false work to give the camber indicated and to allow for shrinkage and settlement.
4. Support formwork on mudsills, concrete foundations or piles to adequately support any construction loads.

3.05 Inspection and Approval:

A. Prior to the pouring of concrete, the designer or his designated agent to inspect the formwork and false work and approve in writing that the work is in compliance with the design drawings. Provide a copy of the written approval to the Engineer.

B. The inspection of the formwork and false work by the Engineer during or after its erection, or any suggestion or assistance furnished by the Engineer, shall not be construed as relieving the Contractor of any part of the responsibility for the accuracy, sufficiency or safety of any formwork or false work, or for the satisfactory completion of the concreting operations.

3.06 Removal:

A. Forms or shoring shall not be removed until the concrete has attained sufficient strength to support its own weight and all constructional loads safely. Formwork of walls, sides of beams can be removed earlier than the formwork for the underside of slabs and beams, this in turn only if it is constructed to permit its removal while leaving the props in place.

B. Striking:

The striking of the formwork shall be done as approved by the Engineer. Unless instructed otherwise by the Engineer, the following table gives the minimum periods that must elapse before the formwork is removed, reckoned from the time the pouring of concrete was completed.

	Position of Formwork and Props	**Minimum Days for Removal**
a.	Walls	1
b.	Sides of beams and columns	1
c.	Slabs (props left under)	3
d.	Props to slabs (spans not	

	exceeding 4 ½ metres)	7
e.	Props to slabs (spans exceeding	
	4 ½ metres)	14
f.	Beams Soffits (props left under)	7
	Props to beams (spans upto 6 metres)	14
g.	Props to beams (spans exceeding	
	6 metres)	21

Note: -

i. If Pozzolona cement is used in any mixture, the above periods shall be modified to the approval of the Engineer.

ii. The contractor should provide the formwork which can be removed without removal of the props to ensure no sagging of the slabs and beams. For slabs, and walls contractor should use plastic coated marine ply.

C. Restrictions:

No permanent load or loads from construction equipment shall be imposed on columns, supported beams or supported slabs until the concrete has attained at least twice the compressive strength necessary to sustain the imposed loads.

D. Concrete Curing:

The concrete shall be thoroughly wetted as soon as the forms are first loosened and shall be kept wet during the removal operations until the curing compound is applied. Potable water with hoses shall be ready at each removal location when removal operations are commenced. In the absence of curing media the concrete shall be wet cured for 7 days or such longer period as directed by the Engineer.

END OF SECTION 03100.

SECTION 03200 REINFORCEMENT

PART 1 -GENERAL

1.01 Reference:

A. Section 03000 applies to and governs the work of this Section.

1.02 Work included:

A. Supply and placing bar and mesh reinforcement for placed in-situ concrete including dowels for masonry work.

B. Provide reinforcement steel bars for masonry work.

C. Provide qualified person to be present at all times to direct and supervise the work, who shall be thoroughly familiar with the material standards and specific requirements of this Section.

1.03 Related Work:

A. The following related work is covered elsewhere in the contract documents:

1.	Site Work	-	Division - 2
2.	Form Work	-	Section 03100
3.	Cast-In-Place (In-Situ) Concrete	-	Section 03300
4.	Masonry	-	Division - 4

1.04 Alternatives:

A. Not applicable for this section.

1.05 Submittals:

A. Submit shop drawings, bar bending schedules, product data and documents as specified in Section 03000, in accordance with Section 01007, and As-Built drawings as per Section 01016.

B. Be responsible for dimensions shown on submittals.

C. Do not proceed with work unless shop drawings are approved by the Engineer.

1.06 Codes and Standards:

A. The following applicable standards established by the Bureau of Indian Standards govern the materials and workmanship for the work under this Section.

1.			IS 432 (Part I) - Mild steel or medium tensile steel bars for concrete reinforcement
2.	IS 1786	-	Cold twisted steel bars for concrete reinforcement.
3.			IS 1139 - Deformed bars for concrete reinforcement, hot rolled mild steel or medium tensile steel.
4.			I.S. 1566 - Fabric for concrete reinforcement, hard drawn steel wire welded wire mesh.
5.	ASTM A.185	-	Welded wire mesh.

B. Where provisions of the pertinent codes and standards conflict with these Specifications, Drawings and Datasheets or with each other, comply with the more stringent provisions.

C. Use the latest issue of Standards.

PART 2 - PRODUCTS

2.01 Reinforcement Bars, Welded Fabric and Tie Wire:

A. Tie wire shall be of annealed steel, 16 gauge minimum.

B. All steel reinforcement shall be Fe 500 Corrosion Resistance D steel conforming to IS 1786. No re-rolled material will be accepted. Submit the manufacturer's test certificate for steel. Random tests on steel may be performed by the Employer as per relevant Indian Standards. Each steel bar shall be identified by the number duly moulded on the bar itself. The Contractor shall bear the costs pertaining to such tests and identification numbers.

C. Steel not confirming to the Specifications shall be rejected.

2.02 Supports and Accessories:

A. Support blocks shall be of concrete with embedded wire ties or dowels for placement on grade or on membranes. Plastic coated spacers or accurately dimensioned concrete blocks shall be used at all water-retaining surfaces, roofs of water-retaining structures and at all interior or exterior surfaces exposed to weather on completion of the structure.

B. The grade of concrete cover blocks shall be the same as the grade of concrete of the various structures.

2.03 Dowels:

A. Where so designated on the Drawings, dowels shall be provided in new work and for anchorage to existing concrete. Where anchorage to existing concrete is shown or required, a non-shrinking epoxy type grout or approved equal or deferred bolting devices shall be provided in each case, conforming to the relevant requirement specified in the Section for cast in-situ concrete.

2.04 Fabrication and Delivery:

A. Tagged reinforcement bundles which can be easily identified shall be stored at the site in sufficient quantities to enable uninterrupted progress of the work. These shall be stored in a manner to prevent damage or undue exposure to weather conditions.

1. Bending and Forming:

   Bars shall be fabricated accurately to dimensions, forms and shapes indicated by methods that will not damage the bars. Heating for purposes of bending will not be permitted. Field-bending of bars that are partially embedded in concrete shall not be allowed unless such procedure is specifically indicated on the drawings or approved by the Engineer.

2. Reinforcement Bars for Masonry:

   Bars required for this purpose and shown on drawings or schedules shall be generally fabricated at the shop and delivered to site for use by masons.

2.05 Corrosion Resistance

A. Reinforcement shall be of corrosion resistant thermo-mechanically treated steel.

2.06 Approved manufacturers for reinforcement steel bars

1. TISCO
2. SAIL
3. Jindal
4. or equivalent as approved with ISI mark / ISO certification.

PART 3 - EXECUTION

3.01 Handling:

A. The bars shall be carefully handled in order to minimize damage. Do not drop them or rub them on hard surfaces or against one another while conveying, placing or stacking the fabricated bars. Use wooden packing battens.

B. Stack the bars off the ground on wooden members and with wooden members between rows of bars or bundles of such tied bars.

C. Workmen or trolleys shall not directly move on the placed bars but may use wooden planks placed on the bars.

3.02 Placing:

A. Placing and tying of reinforcement and welded fabric shall conform to the relevant Indian Standards and where no coverage is made in such standards, according to the manufacturer's standards, including placement tolerances. No reduction in the specified concrete covers will be allowed for bars at surfaces of water-retaining structures.

3.03 Cleaning:

A. Before placing reinforcement and again prior to concrete placement, the reinforcement shall be cleaned of loose mill scale, rust, oil or other coating that would reduce strength or bond. Steps shall be taken to ensure that the reinforcement shall not contact form coatings, release agents, bond breaker or curing compounds.

3.04 Concrete Cover:

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

1. At each end of reinforcement bar, not less than 50 mm.
2. For a longitudinal reinforcement bar in a column, not less than 50 mm, nor less than the diameter of the bar. In case of columns of minimum dimension of 200mm or under, with reinforcement bars of 12 mm and less in diameter, a cover of 40 mm shall be used.
3. For longitudinal reinforcement bars in a beam, not less than 50 mm.
4. For tensile, compressive, shear or other reinforcement in a slab or wall, not less than 40 mm, nor less than the diameter of such reinforcement.
5. For footings and other principal structural members in which the concrete is deposited directly against the ground, cover to the bottom reinforcement shall be 75 mm.
6. For concrete surfaces exposed to the weather or the ground after removal of forms, such as retaining walls, grade beams, footing sides and top, etc., not less than 50 mm.

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

8. For reinforced concrete members, totally or periodically immersed in sea water or subject to seawater spray, the cover of concrete shall be 50 mm more than those specified in (1) to (4) above.

9. For liquid retaining structures, the minimum cover to all steel shall be 50 mm or the diameter of the main bar, whichever is greater. In the presence of sea water and soils and water of corrosive character the minimum cover shall be increased by 25 mm.

10. Protection to reinforcement in case of concrete exposed to harmful surroundings may also be given by providing a dense impermeable concrete. In such a case, the extra cover in (7) and (8) above may be reduced by the Engineer.

11. The correct cover shall be maintained by cement mortar cubes or other approved means. Reinforcement for footings, grade beams and slabs on sub-grade shall be supported on pre-cast concrete blocks as approved by the Engineer. The use of pebbles or stones shall not be permitted.

12. The 28-day crushing strength of cement mortar cubes/pre-cast concrete cover blocks shall be at least equal to the specified strength of concrete.

3.05 Tying In Place:

A. The reinforcement shall be accurately placed and tied securely with rustproof hard drawn steel tying wire at all points where bars cross. Stirrups shall be tied to bars at both top and bottom. The loose ends of the tying wire shall be bent inwards to prevent them projecting out of the concrete cover provided, taking special care at surfaces where a form finish has been specified. Bars and fabric shall be supported as described in Para 2.02.

3.06 Splices:

A. Unless otherwise specified on the Drawing or approved, splices shall be wired contact lap splices. Unless a greater lap length has been specified, splices shall conform to the relevant Indian Standard.

1. Vertical Bars

   No splicing of vertical bars will be allowed except at specified or approved horizontal construction joints.

2. Horizontal Bars

   Splices in horizontal bars shall be lapped with at least one continuous bar between adjacent splices. The minimum spacing of splices in any one run of bar shall be 6 metres. Slabs containing two layers of reinforcement, splices in opposite layers shall be offset at least 1.5 metres.

3.07 Testing:

A. Perform testing of materials as requested by the Engineer, and when so tested, results shall conform to the relevant standards. Tests may be made on bars and stirrups selected by the Engineer from material at site or from any place of distribution. Selection shall include at least two pieces each 500 millimetres long of each sampling.

B. Field Quality Control:

1. Appoint inspectors experienced in this specialty to make constant inspections of the reinforcement during cutting, bending, placing in position, tying and cleaning before pouring concrete. The inspectors shall effect any corrections or irregularities pointed out to him in this respect by the Engineer, as specified in Section 01400 for Quality Control.

a. Inspection of Reinforcement – Covered in section: Cast-In-Place (In-Situ) Concrete

b. Concreting operations:

Appoint the inspectors to be responsible for field quality control who shall inspect the reinforcement continuously during concrete placement to ensure that the bars remain in their correct positions.

c. Welding Inspection:

Inspect all shop and field welded reinforcement steel bars. Welding of reinforcement shall be permitted only with the approval of the Engineer, who shall be given the fullest opportunity to witness the welding operations or have them witnessed by his authorized representatives.

3.08 Welding:

A. Welding of reinforcement shall not be permitted unless indicated or approved in each instance. Welding as a substitute for tying cross bars in position will not be allowed. Where permitted, the bars shall be shop or field welded by experienced welders by the direct electric arc process, using low hydrogen electrodes. The completed weld shall develop a minimum strength of 125 percent of the bar yield strength.

1. Preparation

All surfaces close to the weld shall be cleaned free of loose mill scale or other foreign material. The same precautions shall be taken each time an electrode is charged. Chip burned edges shall be cleaned before new welds are deposited.

2. Characteristics of welds

When wire-brushed, completed welds shall exhibit uniform section, smoothness of welded metal, feather edges without undercuts or overlays, freedom from porosity and clinkers and good fusion, with penetration into base metal. Defective welds or parts of welds shall be cut out with a chisel and welded satisfactorily. Defective welds or parts thereof shall not be removed by using a cutting torch.

3.09 Additional Reinforcement:

A. Submit reinforcement detail at sleeves and openings for approval as per Section 01300 before commencing the work.

B. Additional reinforcement shall be provided at sleeves and openings as indicated or required. If this is not shown on the Drawings or Specifications, the Engineer's attention shall be drawn to this fact and his instructions shall be carried out.

3.10 Welded Wire Mesh:

A. Welded fabric shall be placed on approved supports to hold it in place during concreting. The fabric shall be laid flat in one plane and bent as shown or required to fit the work. Laps shall be a minimum of one mesh unless otherwise detailed. At laps every other wire shall be tied with tying wire.

END OF SECTION 03200

SECTION 03300 CAST IN PLACE CONCRETE

PART 1 -GENERAL

1.01 Reference:

A. This Section of the Specifications shall be read in conjunction with Section 03000 - Concrete, which shall apply to and govern the work of this Section.

1.02 Work Included:

A. Supply and place all cast-in-place concrete work shown on the Drawings, and other work related thereto.

B. The work includes but is not limited to:

1. Liquid-retaining structures;
2. Building works;
3. All foundations including bases for mechanical and electrical equipment;
4. Concrete footpaths and road works;
5. Manholes, ducts, trenches etc;
6. Concrete finishing, patching, grouting and repairs of cracks;
7. Embedded water stops for cast-in-place concrete;
8. Concrete curing;
9. Sealing of joints in liquid-retaining structures or as shown on the Drawings;

C. The Drawings, Datasheets and Specifications are intended to set the acceptable minimum standard.

1.03 Related Work:

A. The following related work is covered elsewhere in the Contract Documents:

1.	Division 2	-	Site Work
2.	Section 03100	-	Form Work
3.	Section 03200	-	Reinforcement
4.	Section 03370	-	Cement Grouting
5.	Section 03372	-	Non-Shrink Grout, Mortar and Concrete
6.	Section 03375	-	Concrete Floor Toppings
7.	Section 03376	-	Epoxy Coating for underground structures
8.	Division 4	-	Masonry
9.	Division 9	-	Finishing

1.04 Alternatives

A. Refer to Section - 01002 for requirements pertaining to acceptance of alternative methods.

1.05 Submittals:

A. Submit drawings, product data and documents as specified in Section 03000 in accordance with Section 01007 and AS BUILT drawings as per Section 01016.

B. Submit to the Consultant for review, design mixes for the various strengths of concrete required. (Refer to the Schedule of Concrete Mixes, Clause 2.02 A).

C. Have the design mixes prepared by the Concrete Supplier giving the exact proportions of all tested and approved materials including cement, water, fine and coarse aggregates, and specified admixtures.

D. Submit mix designs and preliminary test results to the Engineer for approval before commencement of concreting.

E. The contractor to submit a copy of letter of consent of approved ready mix concrete (RMC) supplier to the effect that they would be agreeable to do the RMC work for the said contract. The ready mix contractor to submit design mix for approval to engineer.

F. Manufacturers test report for cement with each supply.

G. The Contractor shall submit drawings indicating all proposed construction joints, both vertical and horizontal, including details of joints, to the Engineer at least three weeks prior to commencement of concreting.

1.06 Quality Assurance

A. Qualifications of Workmen:

1. Qualified staff shall be present at all times to direct and supervise the work and shall be thoroughly familiar with the materials standards, and specific requirements of this Section.

2. Mandatory Tests of materials required for concrete as specified in Section 01008

1.07 Codes and Standards.

A. The following applicable standards established by the Bureau of Indian Standards govern the materials and workmanship for the work under this Section:

Materials

1	IS 269	Specification for 33 grade ordinary Portland cement.
2	IS 8112	Specification for 43 grade ordinary Portland cement.
3	IS 12269	Specification for 53 grade ordinary Portland cement.
4	IS 455	Specification for Portland slag cement.
5	IS 12330	Specification for sulphate resisting Portland cement.
6	IS 1489	Specification for Portland Pozzolana cement (Part 1 & 2)
7	IS 4031	Methods of physical test for hydraulic cement. (Part 1- 15)
8	IS 650	Specification for standard sand for testing cement.
9	IS 383	Specification for coarse and fine aggregates from natural sources for concrete.
10	IS 2386	Methods of test for aggregates for concrete (Part 1 to 8)
11	IS 516	Method of test for strength of concrete.
12	IS 1199	Methods of sampling and analysis of concrete.
13	IS 2062	Steel for general structural purpose.

14	IS 3025	Methods of sampling and test (physical and chemical) (Parts 1 to 49) (physical and chemical) for water and wastewater.
15	IS 432	Specification for mild steel and medium tensile (Part 1 & 2) steel bars and hard-drawn steel wire for concrete reinforcement.
16	IS 1566	Specification for hard-drawn steel wire fabric for concrete reinforcement.
17	IS 4990	Specification for plywood for concrete shuttering work.
18	IS 2645	Specification for integral cement waterproofing compounds
19	BS 4449	Specification for carbon steel bars for the reinforcement of concrete.
20	IS 10262	Recommended guidelines for concrete mix design.
21	SP 23	Handbook on concrete mixes (based on Indian Standards)
22	IS 458	Specification for pre-cast concrete pipes (with and without reinforcement)
23	IS 1786	Specification for high strength deformed steel bars and wires for concrete reinforcement.
24	IS 13620	Fusion Bonded Epoxy coated reinforcing bars specification.
25	IS 1893	Criteria for Earthquake Resistance Design of Structures.
26	IS 13290	Code of Practice for Earthquake Resistance Design and Construction of Buildings.
27	IS 2430	Method for sampling of aggregates for concrete

Equipment

1	IS 1791	Specification for batch type concrete mixers.
2	IS 2438	Specification for roller pan mixer.
3	IS 2505	Specification for concrete vibrators-immersion type-general requirements.
4	IS 2506	Specification for general requirements for screed board concrete vibrators.
5	IS 2514	Specification for concrete vibrating tables.
6	IS 3366	Specification for pan vibrators.
7	IS 4656	Specification for from vibrators for concrete.
8	IS 2722	Specification for portable swing weigh batchers for concrete (single

		and double bucket type).
9	IS 2750	Specification for steel scaffoldings

Codes of Practice

1	IS 456	Code of practice for plain and reinforced concrete.
2	IS 1343	Code of practice for pre-stressed concrete.
3	IS 457	Code of practice for general construction of plain and reinforced concrete for dams and other massive structures.
4	IS 3370	Code of practice for concrete structures for the storage of (Parts 1 to 4) liquids.
5	IS 3935	Code of practice for composite construction.
6	IS 3201	Criteria for design and construction of pre-cast trusses and purlins.
7	IS 2751	Recommended practice for welding of mild steel plain and deformed bars for reinforced construction.
8	IS 9417	Recommendations for welding cold worked steel bars for reinforced concrete construction.
9	IS 2502	Code of practice for bending and fixing of bars for concrete reinforcement.
10	IS 3558	Code of practice for bending and fixing of bars for consolidating concrete.
11	IS 3414	Code of practice for design and installation of joints in buildings.
12	IS 4014	Code of practice for steel tubular scaffolding. (Part 1 & 2)
13	IS 2571	Code of practice for laying in-situ cement concrete flooring.
14	IS 4926	Code of practice for Ready Mix Concrete.

Construction Safety

1.	IS 3696	Safety code of scaffolds and ladders (Part 1 & 2)
2.	IS 7205	Safety code for erection of structural steel work
3.	IS 3764	Safety code for excavation workS

B. Where provisions of the pertinent codes and standards conflict with these Specifications, Drawings and Datasheets or with each other, comply with the more stringent provisions.

C. Use the latest issue of Standards.

PART 2 - PRODUCTS

2.01 Materials:

A. Cement

1. The cement shall be Grade 53 Portland Slag Cement (GGBS shall be between a minimum of 25% and a maximum of 30% of the cement content) as per the IS 455 for use in concrete for pumping stations and related works. Tests shall be carried out as and when directed by the Engineer. The cement shall be tagged for identification at location for sampling.

2. The cement shall be stored in silos or in dry, weather proof and well ventilated structures, the floors of which shall be at least 450 mm above ground level with adequate precautions to prevent moisture absorption. The storage arrangements shall be subject to the approval of the Engineer and shall provide easy access for inspection. The different consignments shall be identifiable and shall be utilized in the order in which they are received at the site or as ordered by the Engineer.

3. Cement stored beyond 60 days from the date of manufacture shall not be used unless tested by approved laboratory and found to be acceptable to the Engineer.

B. Aggregates for Concrete

1. Aggregate for concrete shall be obtained from an approved source and shall conform to IS: 383. Aggregates shall be machine broken and graded aggregate and shall be washed clean at the site if so required by the Engineer.

2. In case of scarcity of natural river sand, machine made sand may be permitted by the Engineer only if it confirms to the quality as per IS 383.

3. The maximum percentages of permissible deleterious materials shall be as follows, subject to total combined impurities, limit of 5 percent by weight.

Impurity (%)	**Coarse Aggregate Uncrushed**	**Crushed**	**Fine Aggregate Uncrushed**	**Crushed**
Clay lumps	1.0	1.0	1.0	1.0
Soft fragments	3.0	-	-	-
Fine material passing through 75 micron sieve	3.0	1.0	3.0	3.0
Shale	-	-	1.0	-
Coal, lignite	1.0	1.0	1.0	1.0

4. The aggregate shall be stored so that different specified sizes are kept separate and protected against contamination by soil or other impurities. Adequate storage facilities to be provided to prevent the possibility of intermixing of the different types of aggregates.

5. The use of wet fine aggregate shall be permitted if the moisture content is uniform and after such content is accurately determined to adjust the batching and the water content of the proposed mix. Wherever possible, the fine aggregate shall be kept dry.

6. The aggregates shall be tested before and after the concrete mix is established and whenever there is a change of the source or character of the materials.

C. Concrete Mixes

1. Grades of Concrete:

a. The concrete used on the works of this project shall be of one of the following grades as indicated on the Drawings and as specified.

Grade	**Minimum Crushing Strength of 150 mm cube at 28 days. In N/mm^2**	
	Preliminary and Trial Mix Tests	**Work Tests**
M - 10	13.5	10.0
M - 15	20.0	15.0
M - 20	26.0	20.0
M - 25	32.0	25.0
M - 30	38.0	30.0
M – 35	44.0	35.0
M - 40	52.0	40.0
M - 50	65.0	50.0

b. All concrete used on the Work shall be dense, sound, homogeneous and durable and free from air voids, bleeding, honeycombing and other allied defects. For grade M-10, an approved nominal mix may be used but for all other grades of concrete, submit mix designs to the Engineer for approval. Bear the costs of additional tests done by an independent Testing Laboratory, at the request of the Engineer. Mixes designed with ordinary cement shall be redesigned if Pozzolona or other cement is to be used. In any case, if Pozzolona or other cement is used or not, new mix designs shall be provided for each new source of supply of cement that is received.

c. To enable this, the cement stocks shall be stored to enable easy identification of different batches.

d. New mix designs will be required if the source of supply of aggregate is changed or a variation exceeding 10 percent in the sieve analysis is observed from the analysis of the aggregate used in the mix design.

2. Mix Designs.

a. Design different concrete mixes for strength, workability and durability of the concrete and strictly in compliance with the relevant standards. If it is found that an increase in the proportion of cement is necessary, the requisite adjustment shall be made at no additional cost. Batching shall be by weight and the combined aggregate shall have a continuous grading.

The mixes shall produce an average 28 day cube strength not less than that specified in clause 3.01 A for trial mix tests for the relevant grade. When admixtures are used, the mixes shall be redesigned with the test strengths conforming to those specified in clause 3.01 A. The workability of the mix shall permit satisfactory compaction with vibration, with no tendency to aggregate during handling, transporting and compaction. When tested in accordance with IS 1199 the consistency of the concrete shall be such that the maximum slump, unless otherwise specified or permitted by the Engineer do not exceed the following values.

b. In exceptional cases, where the reinforcement is so crowded that the compaction is difficult, the value of slump may be increased with the explicit approval of the Engineer, but in no case shall it exceed 150 mm. Any increase in the slump beyond the values given above shall be obtained by the use of additional cement in such quantities to restrict the water-cement ratio to the maximum specified values.

c. The following Table is intended as a basis of the Tender. The Contractor shall arrange for a pre-construction meeting with representatives of those involved with the concrete work and obtain consensus between the parties to achieve the best suited mix designs for the various conditions of cast in place concrete on this project. For the minimum cement contents for the different grades of concrete, refer to the following Table of Concrete Mixes.

Table of Concrete Mixes

Mix Type		**Mix. 400 Thk.<300 mm**	**Mix. 400 Thk.>300 mm**	**Mix. 350**	**Mix. 150**	**Mix. 100**
Concrete Location		As specified in the drawings	As specified in the drawings	As specified in the drawings	As Specified in the Drawings	As Specified in the Drawings
Min. Comp. Strength at 28 days (MPa)		40	40	35	15	10
Cement material	Minimum (kg/m^3)	360	360	340	240	220
Maximum w/c ratio		0.40	0.40	0.40	0.40	0.40
Coarse aggregate (mm)		20	30	20	20	20
Max.Shrinkage rate		0.04%	0.04%	0.04%	0.04%	0.04%
Water Reducing Agent (WRA)		HRWRA *	HRWRA *	HRWRA *	HRWRA *	HRWRA*
	* HRWRA of RHEOBUILD 1125(UT) by BASF or equivalent as approved					

3. Ready Mix Concrete (RMC):

a. The Contract requires using Ready Mix Concrete only of designated strength; procure the same from approved suppliers only. Refer to Section 03300 para 2.01- C-6

b. If small quantity of concrete (less than 10 cu.m) or if concrete is not to be used as structural concrete nominal mix of equivalent strength may be made on site by weigh batching with permission of Engineer.

c. Ready mix concrete prepared and transported will be as per IS 4926.

d. Do not add water to dry mix on site.

e. Ready mix concrete will be brought to the site from the RMC plant only by transit mixers (agitators).

f. Every transit mixer will carry a delivery ticket, noting the minimum following details for every load:

i. Name of Manufacturer and Depot

ii. Serial No. of Ticket.

iii. Date

iv. Truck No.

v. Name of Contractor to whom the RMC is being supplied

vi. Location of contract

vii. Time of loading -Time of receiving at site and time of leaving site

viii. Grade of concrete and batch sheet

ix. Specified workability

x. Cement content and grade of cement

xi. Quantity of materials mixed

g. When the truck arrives on site, the drum, shall always be run at about 10 to 15 rev/min, for at least 3 minutes, to make sure that the concrete is thoroughly mixed and uniform before discharge.

h. Testing of ready mixed concrete: The sampling and testing requirements for ready mixed concrete are the same as those for site mixed concrete.

i. After making sure that the concrete has been uniformly mixed, take a sample from the first 0.5 m3 of concrete discharge and do a slump test on the sample. If the result complies with the specified requirements, then the load shall be accepted. If the results are beyond limits, a further sample shall be taken from the second 0.5 m3 of the discharge, and if this is satisfactory, the load shall be accepted, if not, the concrete load shall be rejected, as the same is not as per the specification range.

j. A minimum of six cubes shall be cast at the plant as well as at the site, where the concrete is placed. Additional cubes to be cast as per IS 456.

k. Any admixture used shall conform to IS 9103.

l. It will be the sole right of the Engineer to reject or accept ready mix concrete. RMC plant based on distance of plant from the site of work, its reputation, number of works in hand etc.

m. Unreinforced Mass Concrete:

i. Mass concrete shall be one of three grades, designated as M-10, M-15 and M-20.

ii. The mass concrete mix shall be specified by volume. For cement which normally comes in bags and is used by weight, volume shall be calculated by taking 50 kg of cement as 0.035 m3 in volume. While measuring, aggregate volume, the aggregate shall not be shaken or compacted. Proportioning of sand shall be as per its dry volume and in case it is damp, allowance for bulking shall be made as per IS 2386.

n. Approved Supplier for Ready Mix Concrete are :

i. M/s. PD Infraproject Pvt.Ltd

ii. M/s Saket Infraproject Ltd.

iii. M/s Konark Structural Engineering Pvt.Ltd. or as equivalent as approved as per latest approved list.

D. Water:

1. Water for mixing concrete shall be clean and free from harmful impurities, such as silt, organic materials, acids, alkalis, salts and oils. The water used shall be of potable quality.

E. Admixtures:

1. The addition of admixtures to alter the properties of the concrete mix shall only be done with the approval of the Engineer in regard to quality, quantity and redesign of the mix, accompanied by separate preliminary tests.

a. High Range Water Reducing Agent (HRWRA)

F. Curing Compound

1. MASTERKURE 107i of BASF

2. or equivalent as approved.

G. Expansion and Movement Joint Materials:

1. Joint Filler: Joint Filler shall consist of proven bituminous compound. Application of the filler shall be strictly in accordance with the manufacturer's instructions.

a. PCI Escutan TF by BASF

b. or equivalent as approved.

2. Water Stops: Water stops shall be extruded from an elastomeric polyvinyl chloride compound containing the plasticizers, resins, stabilizers and other ingredients needed to import the required characteristics or from synthetic rubber And shall have the following properties.

Characteristics	**Properties**
Tensile Strength	116 kg/cm^2 minimum (162 kg/cm^2 minimum for rubber)
Ultimate Elongation	300% minimum (500% minimum for rubber)
Tear Resistance	49 kg/cm^2 minimum
Stiffness in flexure	25 kg/cm^2 minimum
Accelerated Extractions	105kg/cm^2 minimum(150kg/cm^2 Minimum for rubber)
Ultimate Elongation	250% minimum (350% minimum for rubber)
Effect of Alkali (7 days):	
Weight Increase	0.25% maximum
Weight Decrease	0.10% maximum
Hardness change	$\pm$ 5 point
Effect of Alkali (28 days):	
Weight Increase	0.40% maximum
Weight Decrease	0.30% maximum
Dimension Change	$\pm$ 1%

The water-stops shall be 230 mm wide and shall be serrated and have a 19 mm internal diameter centre bulb. The thickness shall depend on the pressure head to which the structure will be subjected at the joint and provide to the Engineer details of the thickness of the water-stop to indicate its adequacy to withstand the design pressures. All water-stop interactions such as ells, tees, crosses etc shall be fabricated by the manufacturer and shall have 61 cm long legs to permit field butt splicing.

3. Joint Sealers: These shall be of impermeable ductile material providing a water-tight seal through the full joint movement range. If the manufacturer recommends the use of a primer to improve adhesion, provide same.

2.02 Plum Concrete:

A. The proportion of plums should not exceed 50 per cent of total volume of plum concrete /plum masonry. The stone size to be used for plum shall be between 200 to 300 mm. The stone shall be basalt, trap or any other approved locally available stone with minimum crushing strength of 10 N/sq.mm obtained from quarries approved by Engineer.

B. The stone shall be hard durable and tough. The length of stone shall not exceed 3 time its height. It will be sufficient to make up the total volume with plums and fill all the interstices, which should not be less than 150cm, with cement concrete. The cement concrete shall be in M10 (cement, sand, coarse aggregate). The coarse aggregate shall be 25 mm down. The water cement ratio shall be adjusted at site to maintain the flowability of concrete to fill all the interstices properly.

C. The plums are laid in layers using the cement concrete as mortar. The plum shall be raised uniformly, and no part, at any time shall be raised more than 900 mm above adjoining work.

D. Double scaffolding shall be provided for construction and piercing of walls for scaffolding shall not be permitted. The contactor shall be responsible for any damage or injury resulting from poor scaffolding.

E. All plum concrete/ plum masonry shall be maintained wet for at least 7 days.Weep holes shall be provided by HDPE pipes buried in plum masonry. The end of the weep holes ,on the filled up side, shall be covered by geo-membrane and filled by gravels of sizes 40 mm. Form work shall be of ply wood or steel .

PART 3 - EXECUTION

3.01 Delivery, Storage and Handling

A. Deliver, store, and handle all materials in a manner which prevents contamination from foreign matter and damage to its fabricated form.

3.02 Preparation before Placing:

A. All excess water shall be removed from the forms before concrete is placed. No flow of water shall be admitted to the section being concreted. The interior faces of forms shall be cleaned and any hard concrete, debris or foreign material removed. The inner faces of the mixing and conveying equipment shall be similarly cleaned.

B. Reinforcement: All reinforcement shall be secured, inspected and approved in compliance with the relevant specifications and shall be inspected and approved by the Engineer before placing concrete. Embedded metal shall be clean and free of old mortar, oil, mill scale and other encrustations and coatings. Wheeled concrete handling equipment shall not run over reinforcement nor shall walkways be supported on reinforcement.

C. Wetting: Wooden forms shall be adequately wetted to tighten up cracks and reduce moisture absorption.

D. Earth Sub Grade: Any earth sub-grade on which concrete is to be deposited shall be wet lightly 24 hours in advance of concreting but not muddied. The sub-grade shall be re-rolled where necessary for a smooth surface and all loose materials removed.

E. Aggregate Fill Base: The same preparations shall be made as for earth sub grade except 30 mil plastic or other approved material sheet shall be placed on the base course to prevent the percolation of fines out of the concrete into the base course.

F. Rock Base: Where placement of concrete direct on rock base is permitted, the rock surface shall be cleaned and washed and loose material removed with air blower or hose before concreting. All standing water collected on the rock surface shall be removed before concreting.

G. Existing Concrete Surfaces: Where a bond between the old and new surfaces is required, the steps and precautions stipulated for Construction Joints shall be adopted. Where no bond is necessary, the existing surface shall be cleaned, removing any dirt or deleterious material which might interfere with the concreting.

H. Water-stops:

1. Water-stops conforming to clause 2.01 shall be provided in all construction joints where shown on the Drawings and in accordance with the manufacturer's instructions. Water-stops shall be continuous in joints, following offsets and angles in joints until spliced to water-stops at intersections thereby completely sealing the structure. The flanges of water-stops shall be secured to the reinforcement with 18 gauge wire ties at a maximum spacing of 45 centimeters or with any PVC binding where that is specifically recommended by the water-stop manufacturer.

2. PVC water-stops shall be neat fused and synthetic rubber water-stops vulcanized at joints and connections unless explicitly otherwise specified by the manufacturer.

3.03 Joints in Concrete:

A. Expansion Joints:

Expansion joints and joints around equipment in concrete paving shall be as detailed in the drawing and shall be formed with an approved bitumen impregnated fibreboard. The upper 20 mm shall be sealed with an approved two part, Polysulphide, oil resistant sealant (H.C. grade) or hot applied bitumen sealing compound, applied strictly in accordance with the manufacturer's instructions.

The joint filler shall be fixed firmly to the first placed concrete before the adjoining concrete is placed. The concrete must be thoroughly compacted on both sides of the joint.

The location and width of expansion joints shall be shown on the engineering drawings.

B. Construction Joints:

1. For normal structures

The number of construction joints shall be kept to the minimum necessary for the execution of the work. Their location shall be carefully considered and approved by Engineer before concrete is placed. Construction joints shall normally be at right angles to the general direction of the member. Concreting programme and its method of execution shall be approved from the Engineer before commencement of work.

The concrete at the joint shall be bonded with that subsequently placed against it, without provision for relative movement between the two. When the work has to be resumed on surface which has hardened, such surface shall be roughened. It shall then be swept clean and thoroughly wetted. For vertical joint neat cement slurry shall be applied on the surface before it is dry. For horizontal joints the surface shall be covered with a layer of mortar about 10 to 15 mm thick composed of cement and sand in the same ratio as the cement and sand in concrete mix. This layer of cement slurry or mortar shall be freshly mixed and applied immediately before placing of the concrete.

Where the concrete has not fully hardened, all laitance shall be removed by scrubbing the wet surface with wire brushes, care being taken to avoid dislodgement of particles of aggregate. The surface shall be thoroughly wetted and all free water removed. The surface shall then be coated with neat cement slurry. On this surface, a layer of concrete not exceeding 150 mm in the thickness shall first be placed and shall be rammed against old work, particular attention being paid to corners and close spots; work thereafter shall proceed in the normal way.

The number, size and positions of props left under shall be able to carry safely. The dead load of the slab, beam or arch together with any live load likely to occur during curing or further construction. Cambers and chamfers, where ever shown in drawing shall be provided accordingly.

3.04 Conveying and Placing Concrete:

A. Concrete shall be poured or placed only after the forms and reinforcement have been inspected and approved by the Engineer. Provide the Engineer at least one day's notice of the need for approval of the forms and reinforcement.

B. Do not use aluminum equipment in any operation where the equipment and concrete are likely to come in contact with each other, unless the aluminium surfaces have been adequately treated to prevent reaction and having harmful effect on the concrete.

C. Weather: No concreting shall be carried out during rains unless adequate steps have been taken to prevent damage to the concrete. Concrete placed in dry winds, low humidity, high temperatures or in other conditions conducive to rapid drying shall be initially cured with a spray of water immediately after the initial set and covered until final curing operations are begun. Other approved methods available shall also be taken to reduce concrete temperature and evaporation during concreting at high temperatures.

D. Conveying: Concrete shall not be released from a mixer, hopper, frame or other conveyance or device through a height exceeding one metre or through reinforcement, in a manner likely to cause segregation. Windows or tremies discharging close to the point of concreting shall be provided as required.

E. The use of chutes will be restricted to specific locations approved by the Engineer. Concrete shall be deposited directly into the conveyance device and from the conveyance device directly into the locations in the structure. Placement of concrete shall maintain a level surface throughout. Manual labour may be used for conveying and placing mixed concrete provided the above requirements are not contravened.

F. Placing Concrete: Concrete shall be placed in position and compacted within 30 minutes after the first addition of water to the mix and no concrete showing signs of initial set shall be used in any part of the works. Re-tampering of set concrete is prohibited. The acceptability of the concrete shall be at the sole discretion of the Engineer.

1. Lifts:

Concrete shall be poured into forms after mixing in a manner that will prevent segregation of the ingredients and in horizontal layers not exceeding 2000 mm thick.

a. Walls: Concrete for walls of water retaining structures, including tank exterior walls, shall be poured, where practicable, as one continuous operation from footing to top of the wall. Each section shall be left in place at least seven days before the adjoining section in similarly concreted.

b. Slabs: Concrete between approved joints shall be poured in one continuous operation in checker-board fashion and shall be allowed to stand at least seven days before adjoining sections are concreted.

c. Concreting of beams and slabs shall be continuous and monolithic with the floor.

2. Pumping Concrete: No increase in the water-cement ratios or specified slumps will be permitted to pumped concrete. The minimum conveyance tube shall be minimum diameter of 100 mm and capable of maintaining the specified pour rates.

3. Pour Rules:

a. Vertical Elements: concrete shall be placed in lifts as specified at a rate that does not cause excessive stresses in the formwork or a hardening of the top layer before next lift is poured.

b. Slabs :Concrete shall be poured at an appropriate time that ensures that all new concrete poured is adjoined to concrete that is still plastic and before the initial set of the previous placing.

c. Construction Joints: Concreting adjoining a construction joint shall not be until the existing surface has been cured for at least seven days, unless otherwise approved by the Employer's Representative.

3.05 Compaction:

A. Provide effective compaction of newly placed concrete by vibration, agitation, spading and rodding. At least two vibrators in dependable working condition shall be available before commencement of concreting and kept in working condition during the scheduled concreting period each in the charge of an experience workman at each point of concrete placement.

1. Vibration:

All concrete, excepting slabs of thickness 100 mm or less, shall be compacted with high frequency, mechanical vibrating equipment supplemented by hand spading and tamping. Concrete slabs of 100 mm or less in thickness shall be compacted by wood or metal tampers, spading and settling with a heavy leveling straight edged beam.

a. Vibrators: These shall be designed to operate with the vibrating element having a frequency of not less than 7000 impulses per minute. The equipment shall, at all times, be adequate, in terms of units and power, to consolidate the poured concrete. Immersion, depending on the structure being concreted and the location of concreting.

b. Operation: the vibrators shall not touch the reinforcement. When vibrating a freshly placed layer, the vibrator shall be pushed down vertically into the preceding plastic layers and withdrawn gradually, producing a dense concrete free of set concrete. The intervals at which the vibrator should be immersed shall not exceed 2/3 of the apparent effective area of vibration of the unit used. Excessive vibration and segregation of aggregates shall be avoided.

c. Re-vibration of Set-Retarded Concrete: For concrete containing an approved set-retarding admixture for structural walls, each layer of concrete have been placed and compacted for at least 30 minutes before the next layer is placed. Bleed water on the surface of the concrete shall be removed before additional concrete is placed and the concrete in place shall be re-vibrated before the next lift. At the top of walls and columns, concrete containing excess water or fine aggregates caused by vibration shall be removed while still plastic and the space filled with compacted concrete of the correct proportion and vibrated into place.

3.06 Slabs:

A. Screeds shall be set at maximum 2.5 metre spacings. Centres and the correctness of elevations shall be checked with an instrument level. The concrete shall be compacted and tamped to bring 10 mm. of mortar to the surface, and wood floated to straight edges and screeds. The finished surfaces shall be level or sloped, as specified, the maximum deviation permissible being 6 mm from a 3m straight edge for exposed finishes. No steel or plastic floats shall be used for initial floating. Unless otherwise specified, special finishes shall be applied only after the surface has sufficiently hardened. All laitance and bleed water shall be removed as it appears.

1. Curing Formed Concrete:

The forms containing concrete shall be maintained in a thoroughly wet condition until they are ready for removal. The surface shall be kept moist with a fine fog spray until protected by curing materials. Curing shall be by use of water curing method or specified liquid membrane forming compound. The method proposed to be employed being subject to the Engineer's approval.

2. Concreting In Hot Weather:

If concreting is carried out when the day temperature exceeds 35ºC at any time within 24 hours of concreting, take special additional steps to the requirements of clause 3.05, as approved by the Engineer, to ensure adequate curing during such periods at no extra cost. No concreting shall be carried out when the day temperature exceeds 45ºC.

3.07 Finishing Formed Concrete:

A. Projections and offsets on the surface of concrete shall be removed as soon as practical.

Voids shall be saturated with water and all voids shall be filled with mortar of the same proportions as present in the concrete, less the coarse aggregates and then cured. All pockets and damaged surfaces shall be cut to sound concrete, with edges square to surface and the back levelled. An epoxy or other approved concrete adhesive shall be applied to fill patched areas with mortar as specified for the voids. The mortar being allowed ½ an hour to temper before use. The patches shall be finished flush with the surrounding surface and cured in the same manner as concrete. For permanently concealed concrete, no other operations are needed.

B. Refer to section 3100 for concrete form finishes. All exposed interior and exterior formed concrete shall be rubbed while still green with cement and burlap or brick and water or both, to eliminate pockets and produce reasonably smooth surfaces suitable for painting, waterproofing and protective coating work. Similar finishes shall be provided on formed concrete surfaces of tank interiors and other water retaining surfaces in contact with water.

C. The following slab surface finishes shall be provided where specified or as shown on the Drawings or as specified by the Engineer.

1. Rough Slabs:

The surface of the slab shall be brushed after the initial set leaving the coarse aggregate slightly exposed. This is applicable to concrete surfaces intended to receive deferred concrete, grout or mortar and tops of footings for masonry.

2. Monolithic Trowel:

Provide monolithic trowel finish for all floor slabs and flat work surfaces unless otherwise specified. After the surface water disappears and the floated surface has hardened sufficiently and the initial set has taken place, that is, when the palm of the hand is placed on the surface, it does not leave an impression and no cement mortar adheres to the palm, trowel and re-trowel the concrete surface to a smooth uniform finish, free of trowel marks or other blemishes. Excessive trowelling that produces shiny areas shall be avoided.

3. Steel Float Finish:

The procedure is the same as for a monolithic trowel finish except that the second trowelling is omitted. This finish will usually be given to floor slabs, surface of water bearing structures and areas intended to receive resilient floor coverings.

4. Wood Float Finish:

The concrete is floated to screeds. When ready, the surface is finished with floats to a uniformly textured surface. This finish is given to exterior walking surfaces exceeding 1:10 slope unless otherwise specified.

5. Swirl Non-slip Furnish:

The surface is prepared as for a steel float finish and the final trowelling is with a circular motion to produce a uniform swirl non-slip finish matching the sample approved by the Engineer from 600 mm square sampler panels prepared by Contractor. Unless otherwise specified, exterior walking surfaces shall have a uniform coarse texture and interior walking surfaces a fine non-slip texture.

6. Abrasive Finish:

This is the same as the non-slip finish, except that just before final trowelling a specified abrasive aggregate shall be applied uniformly and locked into the cement matrix with final trowelling. This finish to be used on stair treads and landings.

3.08 Installation of Pipes, Electrical Conduits etc through Concrete Structures:

A. Wherever required, install in place before concreting, any pipe, electrical conduit or other special that passes through or terminates at any concrete wall. Obtain the prior approval of the Engineer of the shop drawing(s) and method statement, particularly if to leave an opening and install the special later.

B. Where the special is to be concreted in later, the opening shall be accurately fashioned to receive it. Pipes passing through walls or floors of water retaining or earth supporting structures shall be provided with welded thrust or puddle flanges and the opening provided shall be suitably sized.

1. The opening provided shall be of sufficient size to permit accurate final alignment of the embedded fitting without deflecting any part and allowing adequate space for satisfactory spacing where the pipe passes through openings so formed.

2. The boxes or cores shall be provided with continuous keyways to hold the concrete filling in place and ensure water-tightness.

3. The space left within the boxes or cores and around the special positioned in place shall be filled with non-shrink grout or non-shrunk concrete as approved by the Engineer.

3.09 Field Quality Control:

A. Continuous Inspection: All concreting shall be continuously supervised by an authorized representative of the Engineer. Provide at least 24 hours advance notice after approval of the formwork and reinforcement to the Engineer of proposed concrete placements. Any concreting done in the absence of a representative nominated by the Engineer or without the express permission of the Engineer is liable to rejection.

B. Tests: refer to Section 01008

1. All tests specified in the Indian Standards listed in clause 1.07 shall be regularly carried out together with any additional tests the Engineer may require to satisfy himself regarding the quality of the work done.

2. If the results of any tests indicate that the concrete in question is unsatisfactory in any respect, take steps as directed by the Engineer to rectify the same and if such rectification is not found to be satisfactory or adequate, the section in question shall be removed and re-concreted.

3. While all the tests stipulated in the Indian Standards are important, the carrying out of the field slump-tests and the making of the specified works test cubes from every batch of concrete or as otherwise specified by the Engineer shall be carried out without exception.

4. Sampling and testing shall be in accordance with IS 1199 and IS 516. Evaluation of the results and acceptance or rejection of the concrete will be done as described hereinafter at the sole discretion of the Engineer.

5. The minimum frequency of sampling of concrete of each grade shall be in accordance with IS: 456.

6. If a significant difference is noticed between the two sets of results, all further testing shall be done at the approved laboratory until the site equipment is rectified satisfactorily.

7. No reduction in the frequency or number of samples taken shall be made without the explicit approval of the Engineer, who may reduce the number or frequency of samples based on the consistency of good results achieved over an acceptable time period. Any deterioration in quality will result in the more rigorous schedule being re-imposed.

8. The standard deviation and coefficient of variation shall be computed for a set of any 10 consecutive tests. The probable minimum strength of the batch as calculated from the results of the 10 tests, based on failure probability of 1 in 10, shall then be compared with the specified minimum strength for the relevant grade of concrete.

    a. If the calculated minimum strength exceeds the specified minimum strength by 10 percent or more, the concrete mix may be redesigned with a lower cement content if feasible.

    b. If the calculated strength exceeds the specified minimum strength by not more than 10 percent, the mix design shall be used for subsequent batches of concrete.

    c. If the calculated strength falls short of the minimum specified strength but by not more than 10 percent, the decision to accept or reject the representative batch of concrete will be at the sole discretion of the Engineer.

    d. The location of the batch in the structure, the maximum stresses likely to occur therein, the calculated strength of the cubes and other relevant factors will be taken into consideration, but his decision, once given shall not be subject to question or dispute nor shall it be quoted as a precedent subsequently.

    e. If the calculated strength falls short of the minimum design strength by more than 10%, the representative concrete is rejected. The said concrete will then be subjected to a non-destructive test or core test as specified in the IS specification.

    f. All water-retaining structures shall be tested for water-tightness in conformance with the requirements of IS 3370 (Part I) – 1965, Section 10 to the satisfaction of the Engineer.

C. Alterations and Concreting Against Surfaces:

1. Existing concrete surfaces which are to receive new concrete shall be heavily sand-blasted to expose the coarse aggregate and produce a clean, coarse textured surface. Such prepared surfaces shall be coated with an epoxy bonding agent or other approved coating immediately prior to concreting.

D. Testing Facilities:

1. Provide at each Pumping Station site the following field testing equipment:

    a. Weigh-batching for aggregates and cement for use at the Works.

    b. Tests on fine and coarse aggregates moisture concrete.

    c. Equipment for carrying out slump tests under controlled and field conditions.

d. Equipment for testing concrete cubes and cylinders of varying stages

e. Sieve analyses.

2. If required test Carried out on Field Results should be perform under supervision of Engineer and the Test result shall be submitted to the Engineer.

3.10 Repair work

A. If, in the opinion of the Engineer, any voids observed in the concrete structure are irreparable the same shall be dismantled and the structure reconstructed.

B. If, in opinion of the Engineer, any honeycombing observed in concrete is repairable, remove all loose concrete until hard concrete is observed. On confirmation from the Engineer, the honeycombing shall be repaired by using an approved epoxy compound. The repairs shall be carried out as instructed by the epoxy manufacturer. The surface shall be made smooth in line and level with the parent concrete

END OF SECTION 03300

SECTION 03370 CEMENT GROUTING

PART 1 -GENERAL

1.01 Reference:

A. Section 03000 applies to and governs the work of this Section.

1.02 Work Included:

A. Supply and place all cement grout as per approved drawings.

B. Drilling of grout holes and making all required grout connections.

C. Mixing and injecting cement grout material.

D. All re-drilling, flushing, pressure grouting and water pressure checking of grout holes.

E. Care and disposal of water and waste grout.

F. Patching the finished grout holes.

G. Care and disposal of drill cuttings.

1.03 Related Work:

A. The following related work is covered elsewhere in the contract documents.

1. Division 2 - Site Work
2. Section 03300 - Cast in Place (In Situ) Concrete

1.04 Alternatives:

A. Refer to Section 01002 for requirements pertaining to acceptance of alternative methods.

1.05 Submittals:

A. Submit proposed methods to be adopted for cement grouting and product data in accordance with Section 01007.

1.06 Codes and Standards:

A. The following applicable standards established by the Bureau of Indian Standards govern the materials and workmanship for the work under this section:

1	IS 269	Specification for 33 grade ordinary Portland Cement
2	IS 8112	Specification for 43 grade ordinary Portland Cement.
3	IS 12269	Specification for 53 grade ordinary Portland Cement.
4	IS 455	Specification for Portland slag cement
5	IS 6066	Pressure Grouting of rock foundations

B. Where provisions of the pertinent codes and standards conflict with these Specifications, Drawings and Datasheets or with each other, comply with the more stringent provisions.

C. Use the latest issue of Standards.

PART 2 - PRODUCTS

2.01 Materials:

A. Cement and aggregates shall comply with material requirements of Section 03300.

2.02 Grout Mix:

A. Unless otherwise specified elsewhere or recommended by the manufacturer for the particular situation, the grout mix shall be (by volume):

1. 1 part Portland cement
2. 1 ¼ parts fine aggregate
3. 2 ½ parts coarse aggregate (10 mm to 5 mm size)
4. Admixture: 125 ml water reducing admixture/100 kg cement
5. Slump: 0 to 25 mm.

2.03 Approved Manufacturer/ Suppliers:

A. FOSROC

B. BASF

C. ROFF

D. SIKA

E. or equivalent as approved

PART 3 -EXECUTION

3.01 Preparation:

A. Thoroughly roughen and clean surface of all laitance and dirt. Moisten before placing grout.

3.02 Placing, Finishing, Curing and Protection:

A. Refer section 03300.

END OF SECTION 03370.

SECTION 03372 NON SHRINK GROUT

PART 1 -GENERAL

1.01 Reference:

A. Section 03000 applies to and governs the work of this Section.

1.02 Work Included:

A. Supply and place non-shrink grout, mortar and concrete for base plates and bolts pockets of various machines foundations.

1.03 Related Work:

A. The following related work is covered elsewhere in the Contract Documents.

1.	Division 2	-	Site work
2.	Section 03300	-	Cast-In-Place Concrete.
3.	Division 4	-	Masonry
4.	Division 9	-	Finishes

1.04 Alternatives:

B. Refer to Section 01002 for requirements pertaining to acceptance of alternatives.

1.05 Submittals:

A. Submit specification, product data and samples in accordance with Section 01007 and as per Section- 01016.

1.06 Codes and Standards:

A. The applicable standards established by the Bureau of Indian Standards govern the materials and workmanship for work under this Section.

B. Where provisions of the pertinent codes and standards conflict with these Specifications and Drawings or with each other, comply with the more stringent provisions.

C. Use the latest issue of Standards.

PART 2 - PRODUCTS

2.01 Materials:

A. Proprietary non-shrink grout:

1. Non-shrink construction grout (premixed powder) of manufacturer approved by the Engineer.

B. The grout powder shall contain well-graded aggregates, cement and special chemical additives to enable achievement of high early strengths.

2.02 Approved Manufacturer/ Suppliers:

A. FOSROC

B. BASF

C. ROFF

D. SIKA

E. or equivalent as approved

PART 3 - EXECUTION

3.01 Preparation:

A. Thoroughly roughen and clean surfaces of all laitance and dirt. Moisten surfaces before placing grout.

3.02 Proportioning:

A. Comply with manufacturer's recommendations.

B. Add the required quantity of water to maintain a water-powder ratio of 0.125.

3.03 Placing, Finishing, Curing and Protection:

A. Comply with manufacturer's recommendations.

B. Start placing the grout from one end of the pocket only. Do not pour from two sides. The material shall be quickly poured in order to avoid loss of workability.

C. Strike off the exposed areas during placement of the material.

D. Cure grout by placing wet Hessian cloth or use Kem Cure Aid 2 for controlled curing.

E. Do not use vibrators for compacting the material.

F. Finish grout surfaces to match adjacent concrete surfaces.

END OF SECTION 03372.

SECTION 03373 EPOXY GROUT

PART 1 -GENERAL

1.01 Reference:

A. Section 03000 applies to and governs the work of this Section.

1.02 Work Included:

A. Supply and place epoxy grout for patching and thin overlays where good bonding is essential, and as directed by the Engineer.

B. The Drawings, Datasheets and Specifications are intended to set the acceptable minimum standard.

1.03 Related Work by other Divisions:

A. The following related work is covered elsewhere in the Contract Documents.

1.	Division 2	-	Site Work
2.	Section 03300	-	Cast-In-Place Concrete.
3.	Division 5	-	Metals

1.04 Alternatives:

A. Refer to Section 01002 for requirements pertaining to acceptance of alternatives.

1.05 Submittals:

A. Submit specifications, product data, documents and samples in accordance with Section 01007 and AS-BUILT Drawings as per Section - 01016

1.06 Codes and Standards:

A. The applicable standards established by the Bureau of Indian Standards govern the materials and workmanship for the work under this section.

B. Where provisions of the pertinent codes and standards conflict with these Specifications and Drawings or with each other, comply with the more stringent provisions.

A. Use the latest issue of Standards.

PART 2 - PRODUCTS

2.01 Materials:

A. Silica Sand

B. Bonder

C. Resin

2.02 Mixes:

A. Epoxy grout to be mixed as per manufacturer’s instructions.

2.03 Approved Manufacturer/ Suppliers:

A. FOSROC

B. BASF

C. ROFF

D. SIKA

E. or equivalent as approved

PART 3 - EXECUTION

3.01 Preparation:

A. Thoroughly clean surfaces to receive grout by wire brushing, sandblasting or chiselling. Wash with clean water under pressure. Blow off all free water prior to installation of grout.

3.02 Placing and Finishing:

A. Mix in accordance with manufacturer's recommendations. Place, consolidate and strike off to lines and grades as recommended by the manufacturer and as shown on the Drawings and as specified.

END OF SECTION 03373.

SECTION 03375 CONCRETE FLOOR TOPPINGS

PART 1 -GENERAL

1.01 Reference:

A. Section 03000 applies to and governs the work of this Section.

1.02 Work Included:

A. Supply and place all floor toppings as detailed on the Drawings or as directed by the Engineer.

B. The drawings, data sheets and specifications are entered to set the acceptable minimum standard.

1.03 Related work by other Divisions:

A. The following related work is covered elsewhere in the contract documents:

1.	Division 2	-	Site Work
2.	Section 03300	-	Cast-In-Place (In-Situ) Concrete
3.	Division 4	-	Masonry
4.	Division 9	-	Finishes

1.04 Alternatives:

Refer to Section - 01002 for requirements pertaining to acceptance of alternatives.

1.05 Submittals:

A. Submit shop drawings, data sheets, documents and samples in accordance with Section 01007 and as per Section 01016.
   1. Submit mix designs and preliminary test results to the Engineer for approval before commencing work.
   2. Submit samples of admixtures and materials for cement, aggregates and water to the Engineer for approval.
   3. Submit a copy of letter of consent from the BMC approved ready mix concrete plant agreeing to supply the RMC for the said Contract, if the Contractor does not possess his own RMC plant approved by the M.C.G.M

1.06 Codes and Standards:

A. The applicable standards established by the Bureau of Indian Standards govern the materials and workmanship for the work under this Section.

B. Where provisions of the pertinent codes and standards conflict with these Specifications and Drawings or with each other, comply with the more stringent provisions.

C. Use the latest issue of Standards.

PART 2 - PRODUCTS

2.01 Materials:

A. Comply with material requirements of Section 03300.

2.02 Mix for Concrete Floor Toppings:

A. Refer to Schedule of Concrete Mixes in Section 03300.

2.03 Approved Suppliers for Ready Mix Concrete:

A. ACC

B. Lafarge

C. Godrej

D. Or equivalent as approved.

PART 3 - EXECUTION

3.01 Preparation:

A. Refer to Section 03300.

B. Provide a bonding agent suitable for the conditions of service which will provide tensile bond strength with the base concrete in excess of 1.5 MPa. The base course shall be prepared in accordance with the manufacturer's instructions.

3.02 Placing:

A. Refer to section 03300.

3.03 Finishing:

A. Refer to Schedule of Concrete Finishes in Section 03300.

3.04 Curing:

A. Wet cure for a minimum of 10 consecutive days if no bonding agent has been used.

B. If a bonding agent has been used, utilize additional curing methods in accordance with the bonding agent manufacturer's recommendations.

3.05 Inspection and Acceptance:

A. Sixty days after the floor topping has been completed, it will be inspected to ensure that it meets the requirements of these Specifications.

B. Initial inspection to ensure proper bonding to the base concrete will be carried out by tapping the topping with a blunt metal object. Detection of a hollow sound in any area shall be reason to suspect inadequate bonding. Core each area as determined by the Engineer, to evaluate bonding adequacy. Carry out all coring as directed by the Engineer at no additional cost.

C. If delamination of the topping has taken place, remove the topping over the entire affected area and replace with new thoroughly bonded topping in accordance with these Specifications. All such remedial work to replace delaminated or poorly bonded topping shall be undertaken at no additional cost.

END OF SECTION 03375.

SECTION 03376 EPOXY COATING FOR UG CONCRETE STRUCTURES

PART 1 -GENERAL

1.01 Reference:

A. Section 03000 - Concrete, applies to and governs the work of this Section.

B. Section 03300 – Cast-in-Place Concrete.

1.02 Work Included:

A. Supply and place epoxy coating material for protection of concrete structures below ground to the approval of the Engineer.

B. The Drawings and Specifications are intended to set the acceptable minimum standard.

1.03 Related Work by other Divisions:

A. The following related work is covered elsewhere in the contract documents.

1.	Division 1	-	General Requirement
2.	Division 2	-	Site work
3.	Division 5	-	Metals

1.04 Alternatives:

A. Refer to Section 01002 for requirements pertaining to acceptance of alternative materials.

1.05 Submittals:

A. Submit specification product data, documents and samples in accordance with Section 01007.

1.06 Codes and Standards:

A. The applicable standards established by the Bureau of Indian Standards govern the materials and workmanship employed in the manufacture of all equipment.

B. Where provisions of the pertinent codes and standards conflict with these Specifications and Drawings or with each other comply with the more stringent provision

A. Use the latest issue of Standards.

PART 2 - PRODUCTS

2.01 Materials:

A. Solvent free, pitch extended epoxy resin.

B. Bonder

C. The high build, pitch extended epoxy coating shall be a 100% solvent free, tough abrasion resistant protective coating. The product shall exhibit excellent bond strength with the substrate at least exceeding 2.5 MPa when tested as per ASTM D4541. The product shall be formulated to have high build thickness exceeding 150 microns per coat on average and shall be applied to achieve overall thickness of 300 microns in two coats. The product shall be formulated to resist exposure to the accelerated weathering test as per ASTM D4587 and shall not exhibit any flaking or blistering.

2.02 Approved Manufacturer/ Suppliers:

A. BASF

B. or equivalent as approved.

PART 3 - EXECUTION

3.01 Surface Preparation:

A. Ensure concrete is at least 28 days old and sound. Oil, grease, mould release agent, curing membrane and such other contaminants must be removed by mild detergent and water and by thoroughly scrubbing with a soft brush.

B. If the wall surface is damp or water is seeping out the leak shall be repaired before coating.

C. Remove all unevenness such as blowholes, pin holes and other surface defects before application of coating.

3.02 Mixing :

A. Epoxy resin is supplied in pre-proportioned kits for complete mixing.

B. Properly stir each component separately before mixing together to ensure uniform consistency.

C. Combine hardener and base component in a suitably sized container.

D. Mix properly for 3 minutes with a slow-speed drill and wing style mixing paddle at 300-400 rpm until a homogeneous colour is achieved.

E. Keep the paddle below the surface to avoid entrapping air. Do not mix by hand.

3.03 Placing and Finishing:

A. Mix in accordance with manufacturer's recommendations. Place, consolidate and strike off to lines and grades as recommended by the manufacturer.

B. Epoxy coating can be applied using short nap roller, shorthaired brushes or by airless spray.

C. Apply in two coats, each at a WFT of 150 microns, the second coat applied after the first coat has dried (4-6 hours at 30^0C) and at right angles to it.

D. Should application of second coat be delayed, abrade the previous coat to give an adequate mechanical key and wipe with solvent before the application.

END OF SECTION 03376.

SECTION 03400 PRECAST CONCRETE

PART 1 -ENERAL

1.01 Reference:

A. Section 03000 applies to and governs the work of this Section.

1.02 Work Included:

A. Design, manufacture and install all precast concrete work indicated on the Drawings, including but not limited to the following:

1. Design of all pre-cast covers shown on the Drawings
2. Supply of all connection hardware to be cast in
3. Design of all precast concrete units not detailed on the Drawings
4. Fabrication
5. Erection/ Installation
6. Sealing
7. Cleaning

B. The Drawings, Datasheets and Specifications are intended to set the acceptable minimum standard.

1.03 Related Work:

A. The following related work is covered elsewhere in the Contract Documents.

1. Division 2 - Site work
2. Division 9 - Finishes

1.04 Alternatives:

A. Refer to Section 01002 for requirements pertaining to acceptance of alternatives.

1.05 Submittals:

A. Submit shop drawings/product data, documents installation drawings as specified in Section 03000, in accordance with Section 01300 and AS-BUILT Drawings as per Section – 01016.

B. Shop/Production drawings which include:

1. Elevation view of each member
2. Sections and details to indicate quantities and position of reinforcing steel, anchors, inserts etc.
3. Lifting and erection inserts
4. Dimensions and finishes
5. Prestress for strands
6. Design loads and calculations
7. Connections

C. Installation drawings which include:

1. Plans and/or elevations locating and defining all material furnished by the manufacturer
2. Sections and details showing connections, cast-in-items and their relation to the structure
3. Description of all loose, cast-in and field hardware
4. Erection sequences and handling requirements

D. Test Reports:

1. Submit copies of cylinder test reports.

1.06 Codes and Standards:

A. The following applicable standard established by the Bureau of Indian Standards govern the materials and workmanship for the work under this Section:

1. IS 456 - Code of Practice for Plain and Reinforced concrete

B. Where provisions of the pertinent codes and standards conflict with these Specifications and Drawings or with each other, comply with the more stringent provisions.

C. Use the latest issue of Standards.

PART 2 - PRODUCTS

2.01 Certificates:

A. Provide letters signed by the design engineer certifying the following:

1. That he has designed the precast units to the requirements of these Specifications.
2. That he has inspected the manufacture of the precast units and that the units have been manufactured in accordance with the design.

2.02 Materials:

A. Refer to Section 03200 for reinforcement requirements.

B. Refer to Section 03300 for concrete requirements.

2.03 Concrete Strength:

A. Provide concrete with a minimum strength of 350 Kg/cm^2 unless a higher strength is required by the manufacturer or designer.

2.04 Manufacture:

A. General:

1. Refer to all pertinent requirements of IS Standards
2. Clearly mark lifting points and which side is up.

B. Finishes:

Refer to Section 03000 and Section 03100. Unless otherwise specified, use steel panel forms in order to achieve a very smooth and hard concrete finish without air bubbles or other blemish.

PART 3 - EXECUTION

3.01 Examination:

A. Inspection:

1. Before proceeding with any work under this Section, carefully inspect the installed work and verify that all such work is complete to the point where this installation may properly commence.
2. Verify that units will be erected in accordance with all pertinent codes and regulations, the reviewed shop drawings and the original design.

B. Discrepancies:

1. In the event of discrepancies, immediately notify the Engineer.
2. Do not proceed with installation in areas of discrepancy until all such discrepancies have been fully resolved.

3.02 Installation/Erection:

A. Refer to all pertinent requirements of relevant IS Standards.

3.03 Sealing:

A. Seal all joints in accordance with the details shown on the Drawings and as specified.

3.04 Cleaning:

A. Clean exposed faces of pre cast units after erection with fibre brushes, soap and water, then rinse with clean water to leave units in a first class condition.

3.05 Warranty:

A. Provide a warranty from the manufacturer that the precast concrete units will not leak or show evidence of visible cracking due to materials or workmanship for a period of 5 years after completion. Units showing such defects shall be replaced and all affected materials made good to the satisfaction of Engineer.

END OF SECTION 03400.

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SECTION 04000 MASONRY

PART 1 -GENERAL

1.01 Governing Conditions:

A. The General Conditions, Particular Conditions, Bid Data Sheets Instruction to Contractor and the requirements of Division 1 herein before specified, in addition to any and all Addenda, apply to and govern each Section of this Division.

B. This Section of this Division shall be read in conjunction with and shall govern the work of other Sections in this Division.

1.02 Work Included:

A. The work covered by this Section includes, but is not necessarily limited to, the supply of all labour, material and equipment to carry out masonry work including the following:

1. General masonry procedures and practice,
2. Concrete blockwork,
3. Architectural blockwork,
4. Masonry reinforcing mortars
5. Other related work.

1.03 Co-ordination:

A. Co-ordinate with the work of other Divisions before installing work included in this Division. If work is installed without co-ordination with other works, the Engineer may direct that such work be removed, relocated and/or modified as necessary. Comply promptly with any Engineer's requests. Complete any correction and/or additional work, as directed by the Engineer.

B. For coordination requirements refer to Section 01003.s

1.04 Submittals:

A. Submit product data, samples/documents as specified under each section of this Division in accordance with Section 01007 and As-Built Drawings as per Section 01016.

1.05 Codes and Standards:

A. The applicable standards established by the Bureau of Indian Standards govern the materials and workmanship for the work under this Division.

B. Where provisions of pertinent codes and standards conflict with these Specifications and Drawings or with each other, comply with the more stringent provisions.

C. Use the latest issue of Standards.

PART 2 - PRODUCTS

2.01 Materials:

A. General:

1. Comply with product requirements outlined in the individual Sections and/or as specified on the Drawings. Select all other materials, not specifically described but required for the proper completion of work under this Division, subject to approval of the Engineer.

2.02 Fire Protection for materials and equipments:

A. All materials and equipments specified under this division shall be provided in accordance with NFPA 820 and the NEC-Area Electrical Classification details provided on the drawings.

B. Zones indicated in the drawings refers to divisions specified in NFPA 820

PART 3 - EXECUTION

3.01 General:

A. Comply with execution requirements outlined in the individual Sections and/or as specified on the Drawings.

END OF SECTION 04000.

SECTION 04200 UNIT MASONRY

PART 1 -GENERAL

1.01 Reference:

A. Section 04000 applies to and governs the work of this Section.

1.02 Work Included:

A. Provide all labour, materials and equipment necessary to complete masonry work indicated on the Drawings including specified brick, stone masonry, integral waterproofing and damp-proofing where indicated, installation of inserts, lintels, anchors and all work specified herein and as shown on the Drawings.

B. The drawings, data sheets and specification are intended to set the acceptable minimum standard.

1.03 Related Work by Other Divisions:

A. The following related work is covered elsewhere in the Contract Documents:

1. Division 3 - Concrete
2. Division 8 - Doors and Windows
3. Division 9 - Finishes

1.04 Alternatives:

A. Not applicable

1.05 Submittals

A. Samples:

1. Before any masonry materials are delivered to the site, submit two samples of each proposed masonry unit to the Engineer for approval together laboratory test results in accordance with Section 01007 – Submittals.

B. Certification:

1. Prior to delivery of concrete masonry to the job site, provide to the Engineer, a letter from the manufacturers of the concrete masonry units, certifying that all such units delivered to the site are in strict conformance with the provisions of this Section. Also provide to the Engineer laboratory test certificates.

1.06 Codes & Standards:

A. The following applicable standards established by the Bureau of Indian Standards govern the materials and workmanship for the work under this Section:

1	IS: 1077	Specification for common burnt clay building bricks
2	IS: 2212	Code of practice for brickwork
3	IS:2185	Specification for Concrete Masonry Works
4	IS: 2250	Code of practice for preparation and use of masonry mortars
5	IS: 597	Code of practice for construction of stone masonry. Part 1- Rubble stone masonry

6	IS: 3495	Method of test for burnt clay building bricks: Part 1 to 4
7	IS: 4832	Specification for acid resistant bricks
8	IS: 4832	Specification for chemical resistant mortars (Part 2)
9	IS: 4860	Specification for acid resistant bricks
10	IS: 3812	Fly Ash
11	IS: 2116	Sand

B. Where provisions of the pertinent codes and standards conflict with these Specifications and Drawings or with each other comply with the more stringent provisions.

C. Use the latest issue of Standards.

PART 2 - PRODUCTS

2.01 Materials:

A. Bricks

1. Brick shall be well burnt clay bricks of designated class, satisfying the strength criteria and as approved by the Engineer before incorporation in the Work. The bricks shall be hand or machine moulded and shall be free from modules of free lime, visible cracks, flaws, warpage and organic matter.
2. Bricks shall be of a quality approved by the Engineer, free from grit, well burnt, hard, sound, square and with sharp and square edges and shall give a ringing sound when struck with a mallet.
3. Bricks shall be of a uniform size and shape. (229 x 114 x 70 mm). Permissible tolerance on dimension shall be not more than +/- 8%. After 24 hours immersion in water the bricks shall not absorb more water than 25 % of their weight. The bricks shall conform to IS 1077 common burnt clay building bricks.

B. Stone for Stone Masonry

1. Stone shall be selected from quarries approved by the Engineer. Stones shall be hard, durable and tough. Each stone to be laid in the Work in its quarry natural state. Dumb-bell shaped bond stones or headers shall not be used in the Work.

C. Water

1. Water shall be free from deleterious materials, clean and from the Municipal main for filtered water or any other source to the approval of the Engineer.
2. Storage for the water shall be of sufficient size. Arrange for sufficient water of specified quality required for the work. Sufficient water storage tanks to be provided so that two days of masonry work can be executed and then cured for 10 days.

D. Sand

1. Sand shall be sharp, coarse, clean river or pit sand, free from salt, earth, dust, silt or other impurities and subject to the approval of the Engineer.
2. Sand may be washed and or/screened to meet the required quality.
3. Crushed stone sand may be used subject to the approval of the Engineer.

E. Cement

1. Cement shall be Portland cement or Pozzolana cement of approved manufacture and shall comply with relevant Indian standards. Compression and tensile tests shall be made on cement-sand cubes.
2. Cement shall be fresh when delivered. Cement shall be delivered in sound and properly secured bags. Barrels or other packages ready for immediate use and shall be used direct from bag or barrel.
3. Cement shall be stored in a weatherproof, well-ventilated and otherwise suitable shed or godown. The floor shall be not less than 450 mm above the ground level.
4. Maintain a sufficient stock of cement to ensure continuity of the work. Stack each consignment separately to permit easy access for inspection and identification.
5. Cement shall not be used after 90 days from date of manufacture.

F. Concrete Blocks

1. Masonry units of hollow and solid concrete blocks shall conform to the requirements of IS: 2185 (Part 1). Masonry units of hollow and solid light-weight concrete blocks shall conform to the requirements of IS: 2185 (Part 2)
2. Masonry units of autoclaved cellular concrete blocks shall conform to the requirements of IS:2185 (Part 3).
3. The height of the concrete masonry units shall not exceed either its length or six times its width.

The nominal dimensions of concrete block shall be as under Length 400, 500 or 600 mm

Height 100 or 200 mm
Width 100 to 300 mm in 50 mm increments

4. Half blocks shall be in lengths of 200, 250 or 300mm to correspond to the full length blocks. Actual dimensions shall be 10mm short of the nominal dimensions. The maximum variation in the length of the units shall not be more than ±5 mm and maximum variation in height or width of the units shall not be more than ± 3mm. Concrete blocks shall be either hollow blocks with open or closed cavities or solid blocks.
5. Concrete blocks shall be sound, free of cracks, chipping or other defects which impair the strength or performance of the construction. Surface texture shall be as specified. The faces of the units shall be flat and rectangular, opposite faces shall be parallel and all arises shall be square. The bedding surfaces shall be at right angles to the faces of the block. The concrete mix for the hollow and solid concrete blocks/light weight concrete blocks shall not be richer than one part of cement to six parts of combined aggregates by volume. Concrete blocks shall be of approved manufacture, which satisfy the limitations in the values of water absorption, drying shrinkage and moisture movement, as specified for the type of block as per relevant IS code. Contractor shall furnish the test certificates and also supply the samples for the approval of Employer's Representative

2.02 Mortar:

A. Cement mortar shall be used in construction of masonry work as specified in this Section. The proportion of mortar shall be:

		cement: sand ratio
1.	For building work.	
	a) Cement mortar for brick or blockwork masonry (in foundation and plinth)	1:3
	b) Cement mortar for brick or blockwork masonry (in super structure)	1:4
	c) Cement mortar for rubble masonry	1:6
2.	For manhole work	
	a) Construction	1:3
	b) Plaster	1:2

PART 3 - EXECUTION

3.01 Examination:

A. Do not start masonry operations without examining existing related works for any conflict with work done under this Division or any other division.

B. Coordinate with mechanical and electrical works where this affects masonry work. Refer section to 01003 Co-ordination.

3.02 Preparation:

A. Establish line levels and coursing and protect from disturbances.

1. Prepare for build-in of all items whether supplied and installed under this Section or another Division.

B. Mixing Cement Mortar:

1. Mix the mortar in watertight, mechanical mixers. Measure ingredients accurately by volume. Place half the volume of sand and the cement into the mixer and mix until a uniform colour is attained. Add the remainder of the sand and repeat. Then add just enough water to obtain the plasticity required. Operate mixer for at least 3 minutes or until all materials are homogenously blended. Clean the mixer after each batch.
2. All mortar prepared and not used within half hour shall be rejected and shall be removed from the Works. Work mortar over constantly with shovel until used up. Do not re-temper or try to use any mortar that has started to set.

C. Masonry Work:

1. Deliver and handle masonry units by methods that will guard against soiling or chipping. Stockpile masonry units on platforms or other approved supports to keep units free from ground contact. Secure a waterproof covering entirely over each stockpile when masonry work is not in progress. Protect stockpiles at all times from weather, dirt and damage.
2. Stained or chipped masonry units and other materials affected by inadequate protection shall be replaced.
3. Embed dowels and anchor bolts to a minimum depth of 200 mm into solid masonry. Dowels should be encased in 1:2:4 concrete up to a depth of 250mm.
4. Provide lintels as shown on the Drawings over all openings including those required for process, mechanical and electrical works that may not be shown on structural or architectural drawings.

3.03 Stone Masonry:

A. Rubble Masonry

1. Rubble Masonry shall be of best quality blue basalt stone from a quarry approved by the Engineer and shall be constructed in courses not exceeding 450 mm in height.
2. The stones shall be large and carefully laid to break the joints, be flat bedded and laid flush in mortar.
3. No dry work or hollow spaces shall be allowed. Smaller stones shall be placed into the interstices between larger stones to avoid thick beds or joints of mortar.
4. The faces of masonry walls shall be kept plumb or, where batter has to be provided, it shall be uniform.
5. A minimum of fifty percent of stones shall be 0.03 cubic metres or more in volume and shall tail back and bind into the work. Twenty-five percent shall be headers tailing at least 380 mm into the work. One through stone shall be provided for every square metre of the facing in a staggered manner.
6. Quoin stones shall be neatly dressed with a hammer or chiselled to form the required angle and laid header and stretcher alternately. No quoin stone shall be less than 0.03 cubic metres in volume.
7. All work to be well watered until the mortar becomes hard and solid and to be well covered if fresh during the rains.

B. Ashlar or Cut Stone Masonry

1. Stones shall be of specified quality, of uniform colour and free from defects. All stone work shall be worked to such sizes and shapes as shown on the Drawings or as directed by the Engineer.
2. The stones shall be fine dressed or as required on face and to a depth of at least 75 mm from the face on the joints, and rough tooled on beds.
3. All stones shall be set in cement and fine sand and the joints shall not exceed 3 mm in thickness. In the case of non-homogeneous walls and ashlar facing, the stones shall break joint with masonry at the back and the joints shall be broken vertically not less than half the height of the course. The joints shall be properly supported by dovetailing, hooks and clamps etc attached to the steel or concrete frame.
4. All mouldings, cornices and enrichments shall be executed according to details supplied, with care being taken that the edges are sharp and clean. All mouldings and projections etc shall be carefully protected during the progress of the works.

3.04 Installation:

A. Brick Masonry:

1. Every brick shall be thoroughly soaked in water before use until bubbles cease to form. No broken bricks (bats) shall be used except as closures.
2. The courses shall be truly horizontal and plumb. Joints shall be broken vertically and they shall not exceed 12 mm in thickness.
3. The brick work shall not be raised by more than 12 single courses per day.
4. The bricks shall be laid with their dents on the top side if the brick work is cement mortar.
5. Bricks shall be thoroughly bedded and flushed with mortar.
6. The walls shall be carried up evenly, not leaving any part more than one metre lower than another. When circumstances render it necessary to carry on the same section of a building in uneven courses, the bricks shall be raked back to maintain a uniform and effectual bond.
7. The work shall be well watered three times a day for seven days.
8. The brick work shall be protected from rain.
9. Scaffolding shall be provided on both sides of walls and work carried out by masons on both sides of walls of 230 mm or greater thickness. Half brick and brick edge partitions may be constructed by masons on just one side.
10. Scaffolding shall be constructed without runners piercing through the wall.
11. For all brick work in cement mortar, the joints of all surfaces which are to be finished in plaster shall be raked out to depth of 20 mm as the work progresses and before the cement mortar has set.
12. Obtain the Engineer's permission for any openings, sleeves or slots considered necessary but not shown on the Drawings.
13. Lay all masonry true to line, straight and plumb to the tolerances specified. Lay masonry from the face side.
14. Solidly shore all lintels and other beams supporting masonry above before laying any masonry on them. Maintain shoring in place for not less than ten days.
15. Cut masonry accurately to fit snugly around pipes, conduits and ducts. Fill solidly and finish neatly all spaces around such work.

B. Control Joints:

1. Provide control joints in masonry in locations as specified and as shown on the Drawings. Locate control joints at intersecting non-load bearing walls, where non-load bearing walls abut load bearing walls, where walls abut vertical structural elements and in continuous walls at a spacing of not more than eight metres.

C. Damp-proof Course/Flashing:

1. Install damp-proof courses as detailed on the Drawings or if not shown, as follows.
2. Provide DPC on all walls of buildings, on top of plinth walls at least one course above grade.
    a. Before laying the concrete of DPC, the brick layer top shall be plastered smooth with 1:3 CM and shall be treated by applying hot bituminous layer of specified grade and quantity and shall be allowed to set, to receive the concrete layer. Bitumen of penetration A 90 or equivalent where used shall be heated to a temperature of 160° ± 5°C. The hot bitumen shall be applied uniformly all over, so that no blank spaces are left anywhere. It shall not be paid for separately.
    b. Cement Concrete layer: This shall consist of cement concrete of specified proportions and thickness. Edge of damp poof course shall be straight, even and vertical. Side shuttering shall consist of steel forms and shall be strong and properly fixed so that it does not get disturbed during compaction and the mortar does not leak through. The concrete mix shall be of workable consistency and shall be compacted thoroughly to make a dense mass. When the sides are removed, the surface should come out smooth without honeycombing. Continuity shall be maintained while laying the cement concrete layer and laying shall be terminated only at the predetermined location where damp proof course is to be discontinued. There shall be no construction joint in the Damp Proof Course.
    c. Curing: Damp proof course shall be cured for at least seven days, after which it shall be allowed to dry.
    d. Application of Hot Bitumen on concrete surface: Where so directed, hot bitumen in specified quantity shall be applied over the dried up surface of cement concrete, properly cleaned with brushes and finally with a piece of cloth soaked in kerosene oil.
    e. Water proofing Materials: Where so specified, water proofing material of approved quality shall be added to the concrete mixture in accordance with the manufacturer’s specifications stating the quantity of water proofing material in litres or kg per 50 kg of cement and shall not be paid for separately.

D. Other Requirements:

1. Do not tap or shift bricks after mortar has taken initial set.
2. Take special care to prevent mortar and other substances from staining exposed masonry work or falling into cavity.
3. Make provision for cleaning out base of cavity upon completion.
4. Form exposed corners with bull nose units.

5. Install metal door frame in accordance with manufacturers' instructions to present a rigid, true, plumb installation. Fill spaces between hollow metal frames and masonry walls with mortar.
6. Extend masonry partitions to underside of slab, deck or structural member above and secure thereto by approved method.
7. Co-operate with other works in the setting of buried conduits, plumbing, piping, anchor bolts, lintels, recesses, inserts etc.
8. Before placing bricks on floor, the floor should be chiseled to remove loose concrete and mortar. Brush clean with water to expose original concrete floor.
9. The surfaces to which bricks abut should be roughened so that there is proper bonding.
10. Special care to be taken in the construction of 115 mm thick masonry walls. For each 1.2 m height of masonry, an M15 concrete layer, 100 mm thick, over the full width shall be placed with two 8 mm dia reinforcement bars. For openings in walls, similar vertical bends with two 8 mm bars shall be provided.

3.05 Protection:

A. Protect the tops of all unfinished walls with weatherproof coverings at the end of each day or upon stoppage of the work for any reason.

B. Provide temporary support and bracing to all walls during construction to prevent damage due to wind load.

3.06 Cleaning Masonry:

A. Surplus mortar shall be removed immediately from floors, walls and other locations.

B. At completion of pointing, remove all rubbish and surplus material and brush and clean all masonry with water and stiff fibre brush.

3.07 Clean-up:

A. Throughout the masonry operations, keep the site clean and free of unnecessary debris. Upon completion of masonry work and before final acceptance, remove all false work, rubbish and temporary buildings associated with masonry work.

END OF SECTION 04200.

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SECTION 05000 METALS

PART 1 -GENERAL

1.01 Governing Condition:

A. The General Conditions, Particular Conditions, Contract Forms, Instruction to Contractor and the requirements of Division 1 herein before specified, in addition to any and all Addenda, apply to and govern each Section of this Division.

B. This Section covers the general requirements for metal work and shall be read in conjunction with other Sections in this Division.

C. This Section governs the work of other Sections in this Division.

1.02 Work Included:

A. Supply and installation of manufactured items such as structural steel sections, joists, ladders, hatches and other miscellaneous steel, iron and aluminum work.

B. The protection of metalwork as specified, including shop and field painting, galvanizing, and coating of aluminum surfaces which are to be embedded in or in contact with concrete.

C. All shop and field cutting and connections as specified, including rivetting, bolting and welding and the provision of holes and inserts for the installation of other work.

D. Supply of all items and information required as the work progresses.

E. The Drawings, Datasheets and Specifications are intended to set the acceptable minimum standard.

1.03 Co-ordination

A. Co-ordinate with the work of other Divisions before installing work included in this Division. If work is installed without co-ordination with other works, the Engineer may direct that such work be removed, relocated and / or modified as necessary. Comply promptly with the Engineer's request. Complete any correction and/or additional work, as directed by the Engineer at no additional cost to the BMC.

B. For coordination requirements refer to Section 01003.

1.04 Submittals:

A. Submit shop drawings, product data and documents for items as required, not limited to following list, in accordance with Section 01007 - Submittals and As-Built drawings in accordance with Section 01016.

1. Material certificates and test reports
2. Fabricator’s qualification record
3. Welding procedure specifications
4. Welding procedure qualification records
5. Welder qualification records
6. Weld map
7. Inspection reports (on sub-vendors) including painting/galvanizing
8. Construction/installation quality control plans
9. Product data sheets
10. Detailed shop drawings and erection drawings clearly showing thicknesses of metals, construction details, attachments and reinforcing for hardware and other pertinent information.

B. Do not proceed with ordering materials or fabrication until the respective drawings have been approved. Verify dimensions with site conditions before fabricating.

1.05 Codes and Standards:

A. The applicable standards established by the Bureau of Indian Standards govern the materials and workmanship for the work under this Division.

B. Where provisions of the pertinent codes and standards conflict with these Specifications and Drawings or with each other comply with the more stringent provisions.

C. Use the latest issue of Standards.

PART 2 - PRODUCTS

2.01 General:

A. Comply with product requirements outlined in the individual Sections and/or as specified on the Drawings.

B. Select all other materials, not specifically described but required for the proper completion of this Section, subject to the approval of the Engineer.

2.02 Approved suppliers

A. As stated under each Section of this Division.

PART 3 - EXECUTION

3.01 General:

A. Comply with execution requirements outlined in the individual Sections and/or as specified on the Drawings.

END OF SECTION 05000.

SECTION 05120 STRUCTURAL STEEL

PART 1 -GENERAL

1.01 Reference:

A. Section 05000 - Applies to and governs the work of this Section.

1.02 Work Included:

A. Supply and install structural steel as specified herein and as indicated on the Drawings.

B. Design and detail all connections for the work of this Section.

C. The Drawings, Datasheets and Specifications are intended to set the acceptable minimum standard.

1.03 Related Work by Other Divisions:

A. The following related work is covered elsewhere in the contract documents:

1.	Division 9	-	Finishes
2.	Division 11	-	Equipment
3.	Division 15	-	Mechanical
4.	Division 16	-	Electrical

1.04 Alternatives:

A. Not Applicable for this Section.

1.05 Submittals:

A. Submit shop drawings / fabrication drawings, product data, documents for review prior to fabrication in accordance with Section 01007 and As-Built drawings as per Section – 01016.

1. Fabrication drawings giving all the information necessary for the fabrication of the component parts of the assembly including the location, type size, length and details of all welds, nuts and bolts, rivets etc shall be prepared in advance of commencement of the work under this Section.

2. Shop and field rivetting and welding shall be clearly distinguished. A diagram allotting distinct identification marks to each separate piece of steelwork shall be prepared on the fabrication drawings along with a materials quantity take-off table indicating the calculated weight of each item.

3. The fabrication drawings shall be adequate to ensure convenient and correct assembly and erection at site.

1.06 Codes and Standards:

A. The following applicable standards established by the Bureau of Indian Standards govern the materials and workmanship for the work under this Section:

1	IS: 226	Structural Steel (Standard quality)
2	IS: 961	Structural Steel (High Tensile)
3	IS: 1977	Structural Steel (ordinary) - Fe 410-0
4	IS: 2062	Structural Steel (Fusion Welding quality)

5	IS: 1079	Specifications for light gauge structural quality hot rolled carbon steel sheet and strip.
6	IS: 1148	Rivet bars for structural purposes hot rolled.
7	IS: 1149	High Tensile rivet bars for structural purposes.
8	IS: 1367	Technical supply condition of threaded fasteners.
9	IS: 1030	Specifications for steel casting for general engineering purposes
10	IS: 3613	Acceptance tests for wire flux combination for submerged arc welding
11	IS: 1852	Specifications for rolling and cutting tolerances for hot rolled steel products
12	IS: 808	Dimension for hot rolled steel sections
13	IS: 1730	Dimension for steel plate, sheet and strip for structural and general engineering purpose
14	IS: 1732	Dimensions for sound and square steel bars for structural and general engineering purposes
15	IS: 800	Code of Practice for General Construction in Structural Steel
16	IS: 811	Specification for cold formed light gauge structural steel sections
17	IS: 6639	Hexagonal bolts for steel structures
18	IS: 5624	Foundation bolts.
19	IS: 6761	Countersunk-head screws with hexagon sockets
20	IS: 3757	High tensile friction grip bolts
21	IS: 6649	High tensile friction grip bolt washers
22	IS: 919	Recommendations for limits and fits for engineering
23	IS: 6572	Dimensions for pneumatic light rivet snap shanks

B. Where provisions of the pertinent codes and standards conflict with these Specifications and Drawings or with each other comply with the more stringent provisions.

C. Use the latest issue of Standards.

1.07 Quality Assurance:

A. Qualification:

1. Work of this section to be carried out by an approved fabricator/installer of the material/product supplier specified herein. The fabricator/installer to possess a minimum of 5 years proven experience in this type of work.

B. Qualifications of Welders:

1. Use only certified welders for all welding performed in connection with the work of this Section.

PART 2 - PRODUCTS

2.01 Materials:

A. Rolled Sections

B. Arc and Resistance Welding electrodes and equipment

C. High Strength Bolts

D. Shop Paint Primer

2.02 Fabrication:

A. General:

1. Fabricate in accordance with relevant IS Codes

B. Connections:

1. Maintain connections within architectural finishes.

2. Continuously seal HSS connections using continuous welds. .

C. Shop Painting:

1. Thoroughly clean steel work.

2. Paint material under cover and protect until paint is thoroughly dry.

3. Portions of work to be welded or high tensile bolted (friction type) shall not be painted until after welding is completed or nuts have been completely tightened with torque wrench.

4. Portions of work to be encased in concrete shall not be painted, but shall be thoroughly cleaned.

5. Welds to be thoroughly cleaned of slag and other residues before painting.

D. Galvanizing:

1. Hot-dip galvanize exposed lintels in exterior walls and other sections detailed on the Drawings.

2.03 Approved Manufacturers/Suppliers:

A. TATA

B. SAIL

C. Or equivalent as approved.

PART 3 - EXECUTION

3.01 General:

A. Conform to the requirements of IS.800 Code of practice for use of structural steel in general building construction.

B. Design:

1. Ensure that structures, components and members of those items indicated on the drawings are designed by a qualified engineer. Design all connections in accordance with the Drawings and/or specified in the relevant Codes and Standards. Where connection details are not provided, design and provide connections with capacity to carry full reactions of members.

3.02 Delivery, Storage and Handling:

A. Protection:

1. Ensure the structural steel is protected from damage before, during and after installation. Protect the installed work and materials of other trades.

B. Replacements:

1. In the event of damage, immediately make all repairs and replacements necessary to the approval of the Engineer

3.03 Straightening:

A. All materials shall be straight and free from twists. If rectification is necessary it shall be effected by cold working and applying pressure, but not by hammering or any other method that will affect or damage the metal. Material with sharp kinks or bends shall be rejected.

3.04 Cutting:

A. Cutting shall be by shearing, sawing, cropping or gas cutting and shall be square and free from distortion with all burrs removed. If directed by the Engineer, the edges shall be ground afterwards.

B. For gas cutting high tensile steel, sufficient steel shall be left over beyond the required profile to enable all hardened metal to be removed later by machining.

C. Except where material is subsequently joined by welding, no load transmitting surface shall be gas cut.

D. Plate in built-up members shall be end edge planed, except where flats with square edges are used. Plates specified to be planed, milled or chipped, shall be cut in the first instance to a size to allow 3 mm to be planed, milled or chipped from the sides or ends.

E. Edges or gussets not exceeding 8 mm thickness may be sheared in a machine which can take the full side in one cut. Edges of thicker gussets shall be prepared by planing milling or grinding.

F. Edge preparation for welding of surfaces shall be carried out by grinding, planing or milling but not by shearing or cropping.

3.05 Examination:

A. Inspection and Testing:

1. Shop and field inspections shall be carried out by Engineer to ensure that materials and workmanship conform to these Specifications and approved drawings.

2. Prior to installation of the work of this Section, carefully inspect the installed work of others and verify that all such work is complete to the point where this installation may properly commence.

3. Verify that structural steel will be installed in strict accordance with all pertinent codes and regulations, the reviewed shop drawings and the original design.

4. Inspection reports to include condition of material, progress of fabrication in the workshop and erection in field.

B. Discrepancies:

1. In the event of discrepancies, immediately notify the Engineer.

2. Do not proceed with installation in areas of discrepancy until all discrepancies have been fully resolved.

3.06 Erection:

A. Perform welding in accordance with applicable Indian Standards.

B. Touch-up bolts, welds, burned or scratched surfaces with shop primer after steel is erected.

C. Provide shim plates for adjusting the levels and alignments and grouting of the base plate.

3.07 Quality Control:

A. Refer to Section 01008 of Division 1.

B. All structural steel and other materials supplied shall be supported by a manufacturer's test certificate conforming compliance with the relevant specifications. The Engineer may order further sampling and testing on any item brought to site. All costs of such sampling and testing, which shall be at an institution or laboratory acceptable to the Engineer, shall be borne by the Contractor.

C. The Engineer shall have free access at all reasonable times to the manufacturer's fabrication shop or yard and shall be provided with all co-operation and facilities for inspection.

D. Inspection by the Engineer and testing by approved authorities will not relieve the Contractor of his responsibility to fulfill his contractual obligations.

3.08 Clean-up

A. Throughout operations, keep the site clean and free of debris.

3.09 Field Painting:

A. Paint in accordance with Section 09900 as applicable.

END OF SECTION 05120.

SECTION 05500 MISCELLANEOUS METALS

PART 1 -GENERAL

1.01 Reference:

A. Section 05000 - Applies to and governs the work of this Section.

B. Section 05120 - Structural Steel

1.02 Work Included:

A. Supply and install miscellaneous metalwork listed herein, or as specified in other Sections or as shown on the Drawings.

B. Include all anchoring and fastening devices for the work of this Section.

C. The Drawings, Datasheets and Specifications are intended to set the acceptable minimum standard.

1.03 Related Work:

A. The following related work is covered elsewhere in the Contract Documents.

1.	Division 3	-	Concrete
2.	Section 05120	-	Structural Steel
3.	Division 8	-	Doors and Windows
4.	Division 10	-	Specials
5.	Division 11	-	Equipment
6.	Division 13	-	Control and Instrumentation
7.	Division 14	-	Conveying System
8.	Division 15	-	Mechanical
9.	Division 16	-	Electrical

1.04 Alternatives

A. Refer to Section 01002 for requirements pertaining to acceptance of alternatives.

1.05 Submittals:

A. Submit shop drawings, fabrication drawings, installation drawings, product data/ documents prior to commencement of fabrication or the ordering of materials in accordance with Section 01007 and As-Built drawings as per Section - 01016.

B. Show the sizes and location of members and necessary details. Provide templates and show dimensions for setting anchor bolts, sleeves, frames and fastenings.

C. Submit material test and quality certification for each material used on site.

1.06 Codes and Standards

A. The applicable standards established by the Bureau of Indian Standards govern the materials and workmanship for the work under this Section.

B. Where provisions of the pertinent codes and standards conflict with these Specifications and Drawings or with each other comply with the more stringent provisions.

C. Use the latest issue of Standards.

1.07 Quality Assurance:

A. Qualification:

1. Work of this Section to be carried out by an approved fabricator/installer of the material/product supplier specified herein. The fabricator/installer to possess a minimum of 5 years proven experience in this type of work.

B. Qualifications of Welders:

1. Use only certified welders for all welding performed in connection with the work of this Section.

PART 2 - PRODUCTS

2.01 Materials:

A. General:

1. Conform to the latest edition of reference standards. Use all new materials and grades of metals and alloys to suit their application.

B. Steel:

1. In accordance with the latest IS. Code, except where otherwise specified on the Drawings and in specifications.

C. Aluminium:

1. Conform to the chemical composition and mechanical properties as outlined in the appropriate IS Specification. Supply aluminium as specified, except where otherwise specified on the Drawings.

D. Stainless Steel:

1. Conform to the chemical composition and mechanical properties as outlined in the appropriate IS Code Specification for the type of stainless steel required.

E. Concrete Anchors:

1. Adhesive type anchors, sizes as specified or to suit.

F. Fasteners:

1. As required to install equipment / items / material.

G. Primer Paint:

1. As specified in Section 09900.

H. Cold Galvanizing Compound:

1. ZRC (Zinc Compound Paint) Cold Galvanizing Compound.

I. Aluminium Portable Ladders:

1. Telescopic Industrial Ladders.

J. Stainless Steel Ladders:

1. As specified in Section 05515 and on the Drawings.

K. Stainless Steel Railing:

1. As specified in Section 05521 and on Drawingss.

L. Stainless Steel Gratings:

1. As specified in Section 05531 and on Drawings.

M. Stainless Steel Hatches and Chequer Plate:

1. As specified in Section 05560 and on Drawings.

N. Lifting Hooks:

1. As specified on the Drawings.

O. Steel Bollards:

1. As specified on the Drawings.

P. Stainless Steel Plate:

1. Provide stainless steel plate as shown on the Drawings. Plate shall be 316 stainless steel, 6.4 mm minimum thickness. Reinforce plate, where required, to ensure no warping or bending of the plate. Anchor plates to concrete with stainless steel anchors and provide neoprene gasket between plate and concrete.

Q. Other Materials:

1. All other materials not specifically described but required for a complete and proper installation of miscellaneous metals, shall be new, free from rust, appropriate quality of their respective kinds and subject to the approval of the Engineer.

R. General:

1. Fabricate the work true to dimensions, square, plumb, level and free of defects. Accurately fit joints and intersecting members with adequate fastening.
2. Construct the work free from distortion and defects detrimental to the appearance and performance.
3. Provide mechanical fastenings of the same material and finish as the base material on which they occur unless required otherwise for structural or safety reasons.

S. Welding:

1. Perform welding in conformance with IS Codes and by a fabricator approved by the Engineer.
2. Weld stainless steel according to IS Code standards using only certified welders.
3. All welds to be continuous.
4. Grind all welds smooth.
5. After welding, remove burnt slag and passivate the weld.

T. Galvanizing:

1. Hot-dip galvanize all miscellaneous metal work as specified, in accordance with the IS Code to a minimum coating weight of 600g/m^2. Hot dipped galvanized steel to receive a paint finish shall be unpassivated.
2. Repair galvanized coatings damaged by welding during cutting, rough handling during shipping or erection or otherwise, in accordance with IS Code using zinc-rich paints. Dry film thickness on repairs shall exceed the original coating thickness by 25%.

PART 3 - EXECUTION

3.01 Delivery, Storage and Handling:

A. Deliver, store and handle all material in a manner which prevents damage to its fabricated form.

3.02 Site Conditions:

A. Give timely and accurate instructions to others for locations, levels, holes, connections and setting of anchor bolts, sleeves and frames.

B. Examine site conditions and take site measurements prior to fabrications to ensure an accurate and proper fit and an appropriate clearance between surrounding items.

3.03 Examination:

A. Inspection:

1. Before installing any work of this Section, carefully inspect the installed work and verify that all such work is complete to the point where this installation may properly commence.
2. Verify that miscellaneous metalwork may be installed in strict accordance with all pertinent codes and regulations, the reviewed shop drawings and the original design.

B. Discrepancies:

1. In the event of discrepancies, notify the Engineer immediately.
2. Do not proceed with installation in areas of discrepancy until all such discrepancies have been fully resolved.

3.04 Installation:

A. Install the work of this Section using skilled craftsmen in accordance with the best practice and according to manufacturers' recommendations where applicable.

B. Install the work plumb, level and structurally free from defects detrimental to the finished appearance.

C. Insulate, where necessary, to prevent electrolysis due to different metal to metal contact. For aluminium in contact with masonry or concrete apply two coats of an approved bituminous paint or butyl tape.

3.05 Clean-up:

A. On completion of the work of this Section, thoroughly clean all exposed surfaces.

END OF SECTION 05500.

SECTION 05501 ANCHOR BOLTS

PART 1 -GENERAL

1.01 Reference:

A. Section 05000 - Applies to and governs the work of this Section.

1.02 Work Included:

A. Supply and install required anchor bolts complete with washers and nuts.

B. The Drawings, Data sheets and Specifications are intended to set the acceptable minimum standard.

1.03 Related Work:

A. The following related work is covered elsewhere in the Contract Documents:

1.	Division 3	-	Concrete
2.	Division 4	-	Masonry
3.	Division 11	-	Equipment
4.	Division 14	-	Conveying Systems
5.	Division 15	-	Mechanical – General Requirement
6.	Division 16	-	General Electrical Requirement
7.	Section 05515	-	Stainless steel Ladders & Rungs
8.	Section 05521	-	Stainless Steel Railings

1.04 Alternatives:

A. Refer to Section 01002 for requirements pertaining to acceptance of alternatives.

1.05 Submittals:

A. Submit shop drawings, product data/documents in accordance with Section 01007 and As-Built drawings as per Section – 01016.

B. The following information shall be provided for all bolt systems:

1. Data indicating load capacities.
2. Chemical resistance.
3. Temperature limitations.
4. Installation instructions.
5. Evaluation report for expansion and wedge type anchors.

C. Submit samples to Engineer for approval.

1.06 Codes and Standards:

A. The following applicable standards established by the Bureau of Indian Standards govern the materials and workmanship for the work under this Section.

1	IS 2062	Anchor Bolts
2	ASTM-A-320	Anchor Bolts

3 ASTM-E-1512 SIESMIC qualification for bolts

B. Where provisions of the pertinent codes and standards conflict with these Specifications and Drawings or with each other comply with the more stringent provisions.

C. Use the latest issue of Standards.

PART 2 - PRODUCTS

2.01 General:

A. Anchor bolts shall be from 316 AISI type stainless steel.

B. Anchor bolt holes in equipment support frames shall not exceed the bolt diameters by more than 25 percent, up to a limiting maximum over-sizing of 6 mm.

C. Minimum anchor bolt diameter shall be 12 mm. Anchor bolts for equipment mounting and vibration isolation systems shall be provided as required.

D. Tapered washers shall be provided where the mating surface is not square with the nut.

E. Expansion, wedge or adhesive anchors set in holes drilled in concrete after the concrete is placed will not be permitted in substitution for anchor bolts except where otherwise specified.

2.02 Materials:

A. Anchor bolt materials shall be as specified in Table A.

Table A: Anchor Bolt Materials:

Material	Specification
Stainless steel bolts, nuts, washers	ASTM A320, AISI Type 316
Expansion anchors Wedge anchors Adhesive anchors	IS 2062 –Anchor Bolts

2.03 Design:

A. Anchor bolts for equipment frames and foundations shall be designed in accordance with the project seismic zone requirements.

2.04 Approved Suppliers

A. HILTI Bolts, Mumbai

B. Or equivalent as approved.

PART 3 - EXECUTION

3.01 General:

A. Fieldwork, including cutting and threading, shall not be permitted on galvanized items.

B. Dissimilar metals shall be protected from galvanic corrosion by means of pressure tapes, coatings or isolators.

C. Grout anchor bolts with non-shrink or epoxy grouts as required.

3.02 Cast-In-Place Anchor Bolts:

A. Anchor bolts to be embedded in concrete shall be placed accurately and held in the correct position while the concrete is placed or, if specified, recesses or box-outs shall be formed in the concrete and the metalwork shall be grouted in place in accordance with Section 03300.

B. The surfaces of metalwork in contact with concrete shall be thoroughly cleaned.

C. After anchor bolts have been embedded, their threads shall be protected by grease and the nuts screwed on.

3.03 Adhesive Anchor Bolts:

A. Use of adhesive or capsule anchors shall be subject to the following conditions:

1. Use shall be limited to locations where exposure, on an intermittent or continuous basis, to acid concentrations higher than 10 percent, to chlorine gas or to machine or diesel oils is extremely unlikely.

2. Use shall be limited to applications where exposure to fire or exposure to concrete or rod temperature above 50° C is extremely unlikely. Such anchors shall not be used in overhead applications.

3. Obtain approval from the Engineer for specific application and from supplier of equipment to be anchored, if applicable.

4. Anchor bolts shall be threaded or deformed for their full length of embedment and shall be free of rust, scale, grease and oils.

5. Embedment depth shall be as per manufacturer's recommendations. Adhesive capsules of different diameters may be used to obtain proper volume for the embedment, but no more than two capsules per anchor may be used. When installing different diameter capsules in the same hole, the larger diameter capsule shall be installed first. No extension or protrusion of the capsule from the hole is acceptable.

6. All installation recommendations by the anchor system manufacturer shall be followed carefully.

7. Holes shall have rough surfaces.

8. Holes shall be cleaned with compressed air and be free of dust or water prior to installation.

9. Anchor bolts shall be left undisturbed and unloaded for the full adhesive curing period.

10. Concrete temperature (rather than air temperature) shall be compatible with curing requirements of adhesives.

11. The anchor bolt product shall have siesmic qualifications as per ASTM-E-1512 - SIESMIC qualification for bolts.

3.04 Expansion Anchors:

A. Provide to the Engineer independent current evaluation reports for the particular brand of expansion anchors to be used, duly certified by the manufacturer's stamp.

END OF SECTION 05501.

SECTION 05516 GALVANIZED IRON LADDERS AND RUNGS

PART 1 -GENERAL

1.01 Reference:

A. Section 05000 applies to and governs the work of this Section.

1.02 Work Included:

A. Supply and install Galvanized Iron access ladders, rungs, supports, S.S. fasteners and anchors as detailed for Valve chamber, Pipe Trench etc. on the Drawings and as specified.

B. Provide fall arrest systems and/or safety cages and landings as specified.

C. Comply with all pertinent requirements of Section 05500 including installation.

D. The Drawings, Datasheets and Specifications are intended to set the acceptable minimum standard.

1.03 Related Work:

A. The following related work is covered elsewhere in the Contract Documents:

1.	Division 3	-	Concrete
2.	Division 4	-	Masonry
3.	Section 05120	-	Structural Steel
4.	Section 05500	-	Miscellaneous Metals
5.	Division 9	-	Finishes

1.04 Alternatives:

A. Not Applicable for this Section.

1.05 Submittals:

A. Submit shop drawings of all products prior to fabrication in accordance with Section 01007 and As-Built drawings as per Section 01016.

1.06 Codes and Standards

A. The applicable standards established by the Bureau of Indian Standards govern the materials and workmanship for the work under this Section.

B. Where provisions of the pertinent codes and standards conflict with these Specifications and Drawings or with each other comply with the more stringent provisions.

C. Use the latest issue of Standards.

1.07 Quality Assurance:

A. Qualification:

1. Work of this Section to be carried out by an approved fabricator/installer of the material/product supplier. The fabricator/installer to possess a minimum of 5 years proven experience in this type of work.

B. Comply with the requirements of the Industrial Safety Requirements as per Section 01060 and Section 01008.

PART 2 - PRODUCTS

2.01 Materials:

Fasteners	Stainless steel, AISI type 316
Concrete Anchors	Stainless steel threaded rod and adhesives,
Side rails:	50 mm x 12 mm G.I. bars, drilled to receive ladder rungs, unless otherwise shown on drawings.
Ladder Rungs	20 mm OD G.I. bar which penetrate the vertical rails and are plug welded on the outside of the rail
Supports	75 mm x 12 m G.I. flat bars shaped, with one end welded to side rails and other end anchored to the wall as detailed on drawings.
Safety cages:	6 mm x 40 mm G.I. hoops spaced at 600 mm c/c, connected by 6 mm x 40 mm G.I. flats
Wall Rungs:	**20 mm OD G.I.** bar bent to shape and welded to 60 mm x 150 mm x 6 mm thk**.** G.I. mounting plate as detailed on drawings.

PART 3 -EXECUTION

3.01 Fabrication:

A. Be responsible for required accurate field measurements before fabrication.

B. Accurately cut, form and machine ladder components.

C. Grind all sharp edges / corners smooth.

D. All welds to be continuous.

1) All steel parts of the fabricate parts shall be hot dip galvanized in accordance with the IS Code 2629 to a thick coat of minimum 600 gms/m2.

2) Fully fabricated grating shall be hot dip galvanized and welding, cutting, drilling etc. shall not be allowed after galvanizing.

3) Repair galvanized coating, damaged during transport or erection, in accordance with I.S. Code using Zine-rich paints. Dry film thickness on repairs shall exceed the original coating thickness by 25%.

3.02 Installation:

A. Install ladders where indicated on the Drawings. Ladders longer than 4300 mm between landings shall be provided with either safety cages extending from the upper landing to within 2100 mm of the bottom landing, or a fall arrest system.

B. Ladder rungs shall extend 900 mm above the floor surface. Ladders not projecting above the floor surface shall be equipped with a pair of wall-mounted grab bars. If no wall is present, equip the ladder with a retractable safety handle extension.

END OF SECTION 05516.

SECTION 05521 STAINLESS STEEL RAILING

PART 1 -GENERAL

1.01 Reference:

A. Section 05000 applies to and governs the work of this Section.

1.02 Work Included:

A. Design, fabricate, supply and install stainless steel 304(Schedule 10) hand railings where indicated on the Drawings.

B. Comply with all pertinent requirements of Section 05500 including installation.

C. The Drawings, Data sheets and Specifications are intended to set the acceptable minimum standard.

1.03 Related Work:

A. The following related work is covered elsewhere in the Contract Documents:

1.	Division 3	-	Concrete
2.	Division 4	-	Masonry
3.	Section 05120	-	Structural Steel
4.	Section 05500	-	Miscellaneous Metals

1.04 Alternatives:

A. Not applicable for this Section.

1.05 Submittals:

A. Submit shop drawings products data/documents prior to fabrication in accordance with Section 01007 and As-Built drawings as per Section – 01016.

B. Submit material test certificate from the manufacturer.

C. Submit a sample of a welded x-cross connection between a post and intermediate rail.

1.06 Codes and Standards:

A. The following applicable standards established by the Bureau of Indian Standards govern the materials and workmanship for the work under this Section.

1. National Building Code of India.
2. BSEN 10025 GR S275 JR/BS 4360 Gr.43A - Material of Construction

B. Where provisions of the pertinent codes and standards conflict with these Specifications and Drawings or with each other comply with the more stringent provisions.

C. Use the latest issue of Standards.

1.07 Quality Assurance:

A. Qualification:

1. Work of this section to be carried out by an approved fabricator/installer of the material/product supplier. The fabricator/installer to possess a minimum of 5 years proven experience in this type of work.
2. Welder: Use only welders certified by the competent authority.

PART 2 - PRODUCTS

2.01 Materials:

A. Stainless steel: Refer to Section 05500 for materials.

B. Fasteners: Stainless steel AISI 316 Type.

C. Horizontal rails: Schedule 10S 48.3 mm OD stainless steel pipe, 3.69 wall thickness, AISI 316 type, unless otherwise shown on the Drawings.

D. Vertical posts: Schedule 10S 48.3 mm OD stainless steel pipe, 3.69 wall thickness, AISI 316 type, unless otherwise shown on the Drawings.

E. Base plates: 10 mm thick x 252 mm x 120 mm stainless steel AISI 316 type, unless otherwise shown on the Drawings.

F. Concrete anchors: Hilti stainless steel threaded rod and adhesive type sizes as specified on the Drawings.

G. Expansion Joints: Provide tight fitting, semi-concealed internal stainless steel pipe sleeves.

H. Safety chains: Provide two sets of stainless steel safety chains at openings in handrails where shown on the Drawings. The chains shall be fixed to the handrail at one end and provided with a stainless steel safety snap at the other. Chain links shall be 19 mm long with 5 mm cross-section.

2.02 Fabrication:

A. General:

1. Verify dimensions on site prior to shop fabrication
2. Assemble items in the workshop to the greatest extent practicable to minimize field splicing and assembly. Disassemble units only as necessary for shipping and handling. Clearly mark units for reassembly and coordinated installation.
3. Make the clear distance between components of any handrail infill such that 100 mm diameter sphere cannot pass through opening.

B. Fabricate toe boards or kick plate of 125 mm high by 6 mm 316L stainless steel plate unless noted otherwise. Fasten to each vertical post with two full penetrating 6mm dia self-tapping SS screws. Provide overlap joints at handrail expansion joints.

C. Handrail:

1. Fabricate as indicated on the Drawings with continuous top rails and vertical posts with intermediate rails mitered in. Do not cut vertical posts.
2. Top rail height (top of round pipe) 1100 min/ 1200 max above floor level.
3. Posts: Equally spaced at maximum of 1500 mm c/c unless otherwise indicated.

D. Handrail at Stairways:

1. Fabricate as indicated on Drawings with continuous top rails and vertical posts with intermediate rails mitered in. Do not cut vertical posts.
2. Top rail height (top of round pipe) 1000 min above steps.
3. Vertical Posts: Equally spaced at maximum of 1400 mm c/c unless otherwise indicated.
4. Extend railings 300 mm plus one tread beyond bottom riser where not continuous.

E. Handrail Joints: Continuous, welded mitered joints. Bolted or riveted connections are not acceptable.

F. Removable handrail: Provide where indicated and as detailed on the drawings. Provide each location with a complete rectangle, four 'L' shaped hooks and four 25Φ eyelets.

2.03 Approved Suppliers/Manufacturers

A. West Coast Engineering Works Pvt. Ltd,

B. Or equivalent as approved.

PART 3 - EXECUTION

3.01 Examination:

A. Examine conditions and proceed with Work in accordance with Section 01008.

B. Verify installation tolerances of items embedded in other work:

1. Spacing: +/- 10 mm.
2. Alignment: +/- 6 mm.
3. Plumbness: +/- 3 mm.

3.02 Preparation:

A. Coordinate drawings, diagrams, templates, instructions and directions for installation of anchorages, concrete inserts and anchor bolts.

3.03 Installation:

A. Install in accordance with approved Shop Drawings.

1. Fit exposed connections accurately to form tight, hairline joints. Make joints as strong and rigid as adjoining construction. Fully weld joints and seams and dress smooth where exposed.
2. Set posts plumb and align to within 6 mm in 4 m. Set rails horizontal or parallel to rake of steps or ramp to within 6 mm in 4 m.
3. Anchor posts with floor flange or fascia flange and fascia brackets to concrete with concrete adhesive anchors and to steel by bolting or field welding.
4. At stairways, install with minimum 55 mm clearance from inside face of handrail to finished wall surface.
5. Handrail Brackets at Walls: Provide at 150 mm from end and spaced equally at maximum of 1500 mm unless otherwise indicated on Drawings.
6. Railing Expansion Joints: Provide slip joint with internal sleeve extending 50 mm beyond joint on each side.
   a) Fasten sleeve one side only.
   b) Locate expansion joints within 150 mm of post.
   c) Provide at intervals of maximum 6 m centres.
7. Railing on Top Parapet Walls: Provide a single row of 316 stainless steel handrail as specified for hand railing above, set at 300 above top of parapet. Vertical posts set equally apart at 1500 c/c max.
8. Field welding shall be carried out in accordance with the same procedures as shop fabrication requirements, ensuring weld slag is removed and passivated.

3.04 Cleaning and Protection

A. Perform immediately after erection.

END OF SECTION 05521.

SECTION 05531 STAINLESS STEEL GRATINGS

PART 1 -GENERAL

1.01 Reference:

A. Section 05000 applies to and governs the work of this Section.

1.02 Work Included:

A. Design, fabricate, supply and install stainless steel gratings.

B. Gratings are to be duly pickled and passivated.

C. Stainless steel grating shall be supported on mild steel galvanised intermediate beams and brackets with columns (as required) at an appropriate place as per layout drawings.

D. Comply with all pertinent requirements of Section 05500 including installation.

E. The Drawings, Datasheets and Specifications are intended to set the acceptable minimum standard.

1.03 Related Work:

A. The following related work is covered elsewhere in the Contract Documents:

1.	Division 3	-	Concrete
2.	Division 4	-	Masonry
3.	Section 05120	-	Structural Steel
4.	Section 05500	-	Miscellaneous Metals

1.04 Alternatives:

A. Not applicable for this Section.

1.05 Submittals:

A. Submit shop drawings product data, documents prior to fabrication in accordance with Section 01007 and As-Built drawings as per Section 01016.

B. Submit material test certificates from the manufacture.

C. Together with the grating shop drawings, submit a design table / schedule stamped / signed by a professional engineer. The table / schedule to include as minimum the following:

1. Name of each location/area of grating installation
2. Location / area size (L x W)
3. Design span to be used for each location indicating where intermediate beam supports are required.
4. Depth, size (L x W) and material thickness of grating at each location.
5. Allowable deflection of each location span based on specified maximum deflection.
6. Calculated deflection of each location.

D. Submit a sample of the proposed grating at time of shop drawing submittal.

1.06 Codes and Standards:

A. The following applicable standards govern the materials and workmanship for the work under this Section.

1. BS-4592 or NAAMM - Specification for fabrication of gratings and dimensional tolerance

B. Where provisions of the pertinent codes and standards conflict with these Specifications and Drawings or with each other comply with the more stringent provisions.

C. Use the latest issue of standards.

1.07 Quality Assurance:

A. Qualification:

1. Work of this section to be carried out by an approved fabricator/installer of the material/product supplier. The fabricator/installer to possess a minimum of 5 years proven experience in this type of work.

2. Welders - use only welders certified by the competent authority for the work of this Section.

PART 2 - PRODUCTS

2.01 Materials:

A. Stainless steel: Refer to Section 05500 for materials.

B. Fasteners: Stainless steel, AISI Type 316.

C. Concrete Anchors: Stainless steel threaded rod and adhesive, sizes to suit.

D. Design gratings to support a minimum uniform live load of not less than 750 Kg/m^2 with a maximum deflection of $^1/_{150}$ of the span.

1. All gratings shall be heavy duty design, removable type with properly designed anchor bolts, clamps and fixtures to ensure sturdy assemblies of platforms,trench covers and covers for chambers etc. without any warping.

2. The designed deflection shall not be greater than 5 mm for concentrated load of 500 kg/sq.m.

3. The size and number of panel shall be designed to suit length and breadth of area to be covered, as shown in drawings. All panels at one location should, so far as possible, be of same size.

E. Supports:

1. Concrete slab openings: Use equal leg stainless steel angles of 6 mm thickness, with a minimum bearing distance of 40 mm. Provide welded-on 'L' shaped anchors at 450 c/c for cast in place grating frames.

2. Openings at walls: Use unequal leg stainless steel angles of 6 mm thickness, with min. bearing distance of 40 mm. Provide vertical leg at least 100 mm long complete with drill-in anchors at 450 c/c.

2.02 Manufacture:

A. Fabrication of gratings to conform to BS 4592 or NAAMM specification.

B. Fabricate gratings from solid rectangular bars with minimum 3mm thickness and a minimum depth of 40 mm and as required to suit the design span. Fabricate the grating in a 41 x 100 grid layout, such that the main span load bearing bars are 41 mm apart and the interconnecting spacer bars are 100 mm apart. Positively interlock the main load bars and spacer bars via welding or mechanically. Provide the top of the main load bearing bars with a non-slip serrated profile. The serrated profile shall be in addition to the minimum grating depth of 40mm.

C. Maximum grating panel width in the non-span direction shall be 1000 mm.

2.03 Approved Suppliers / Manufacturers:

A. West Coast Engineering Pvt. Ltd.,

B. or equivalent as approved.

PART 3 - EXECUTION

3.01 Installation:

A. Install grating panels with carrier or spacer bars lined up to maintain a continuous appearance and fasten securely to supports.

B. Provide suitable stainless steel clips to prevent shifting and warpage.

C. Provide support members required to maintain the allowable deflection.

3.02 Internal Inspection:

A. All gratings will be checked for dimensional and visual quality. Dimensional tolerances shall be as per BS 4592.

END OF SECTION 05531.

SECTION 05532 GALVANISED IRON GRATINGS

PART 1 -GENERAL

1.01 Reference:

A. Section 05000 applies to and governs the work of this Section.

1.02 Work Included:

A. Design, fabricate, supply and install Galvanised Iron gratings.

B. Gratings are to be duly pickled and passivated.

C. G.I. grating shall be supported on mild steel galvanised intermediate beams and brackets with columns (as required) at an appropriate place as per layout drawings.

D. Comply with all pertinent requirements of Section 05500 including installation.

E. The Drawings, Datasheets and Specifications are intended to set the acceptable minimum standard.

1.03 Related Work:

A. The following related work is covered elsewhere in the Contract Documents:

1.	Division 3	-	Concrete
2.	Division 4	-	Masonry
3.	Section 05120	-	Structural Steel
4.	Section 05500	-	Miscellaneous Metals

1.04 Alternatives:

A. Not applicable for this Section.

1.05 Submittals:

A. Submit shop drawings product data, documents prior to fabrication in accordance with Section 01007 and As-Built drawings as per Section 01016.

B. Submit material test certificates from the manufacture.

C. Together with the grating shop drawings, submit a design table / schedule stamped / signed by a professional engineer. The table / schedule to include as minimum the following:

1. Name of each location/area of grating installation
2. Location / area size (L x W)
3. Design span to be used for each location indicating where intermediate beam supports are required.
4. Depth, size (L x W) and material thickness of grating at each location.
5. Allowable deflection of each location span based on specified maximum deflection.
6. Calculated deflection of each location.

D. Submit a sample of the proposed grating at time of shop drawing submittal.

1.06 Codes and Standards:

A. The following applicable standards govern the materials and workmanship for the work under this Section.

1. Fabrication, dimensional tolerance and hot dip galvanizing of gratings shall be in accordance with relevant I.S. Codes.

B. Where provisions of the pertinent codes and standards conflict with these Specifications and Drawings or with each other comply with the more stringent provisions.

C. Use the latest issue of standards.

1.07 Quality Assurance:

A. Qualification:

1. Work of this section to be carried out by an approved fabricator/installer of the material/product supplier. The fabricator/installer to possess a minimum of 5 years proven experience in this type of work.

2. Welders - use only welders certified by the competent authority for the work of this Section.

PART 2 - PRODUCTS

2.01 Materials:

A. Galvanised Iron: Refer to Section 05500 for materials.

B. Fasteners: Stainless steel, AISI Type 316.

C. Concrete Anchors: Stainless steel threaded rod and adhesive, sizes to suit.

D. Design gratings to support a minimum uniform live load of not less than 750 Kg/m^2 with a maximum deflection of $^1/_{150}$ of the span.

1. All gratings shall be heavy duty design, removable type with properly designed anchor bolts, clamps and fixtures to ensure sturdy assemblies of platforms,trench covers and covers for chambers etc. without any warping.

2. The designed deflection shall not be greater than 5 mm for concentrated load of 500 kg/sq.m.

3. The size and number of panel shall be designed to suit length and breadth of area to be covered, as shown in drawings. All panels at one location should, so far as possible, be of same size.

E. Supports:

1. Concrete slab openings: Use equal leg stainless steel angles of 6 mm thickness, with a minimum bearing distance of 40 mm. Provide welded-on 'L' shaped anchors at 450 c/c for cast in place grating frames.

2. Openings at walls: Use unequal leg stainless steel angles of 6 mm thickness, with min. bearing distance of 40 mm. Provide vertical leg at least 100 mm long complete with drill-in anchors at 450 c/c.

2.02 Manufacture:

A. Fabrication of gratings to conform to BS 4592 or NAAMM specification.

B. Fabricate gratings from solid rectangular bars with minimum 3mm thickness and a minimum depth of 40 mm and as required to suit the design span. Fabricate the grating in a 41 x 100 grid layout, such that the main span load bearing bars are 41 mm apart and the interconnecting spacer bars are 100 mm apart. Positively interlock the main load bars and spacer bars via welding or mechanically. Provide the top of the main load bearing bars with a non-slip serrated profile. The serrated profile shall be in addition to the minimum grating depth of 40mm.

C. Maximum grating panel width in the non-span direction shall be 1000 mm.

2.03 Approved Suppliers / Manufacturers:

A. West Coast Engineering Pvt. Ltd.,

B. or equivalent as approved.

PART 3 - EXECUTION

3.01 Installation:

A. Install grating panels with carrier or spacer bars lined up to maintain a continuous appearance and fasten securely to supports.

B. Provide suitable stainless steel clips to prevent shifting and warpage.

C. Provide support members required to maintain the allowable deflection.

3.02 Internal Inspection:

A. All gratings will be checked for dimensional and visual quality. Dimensional tolerances shall be as per BS 4592.

END OF SECTION 05532.

SECTION 05560 STAINLESS STEEL HATCHES

PART 1 -GENERAL

1.01 Reference:

A. Section 05000 applies to and governs the work of this Section.

1.02 Work Included:

A. Design, fabricate, supply and install access hatches as shown on the Drawings and as specified, for pump house and pipe trenches.

B. Design, fabricate, supply and installation of frames and appurtenances associated with the above.

C. Comply with all pertinent requirements of Section 05500 – Miscellaneous Metals, including installation.

D. The Drawings, Datasheets and Specifications are intended to set the acceptable minimum standard.

1.03 Related Work:

A. The following related work is covered elsewhere in the Contract Documents:

1.	Division 3	-	Concrete
2.	Division 11	-	Equipment
3.	Section 05120	-	Structural Steel
4.	Section 05520	-	Miscellaneous Metals

1.04 Alternatives:

A. Not applicable for this Section.

1.05 Submittals:

A. Submit shop drawings, fabrication drawings, installation drawings, product data/ documents prior to commencement of fabrication or the ordering of materials in accordance with Section 01007 and As-built drawings as per Section - 01016.

B. Provide samples sized to represent material adequately.

1.06 Codes and Standards:

A. The following applicable standards established by the Bureau of Indian Standards govern the materials and workmanship for the work under this section.

1	IS 6911	Stainless steel sheet and strip.
2	IS 12817	Specifications for stainless steel butt hinges
3	IS 3502	Steel chequered plate

B. Where provisions of the pertinent codes and standards conflict with these Specifications and Drawings or with each other comply with the more stringent provisions.

C. Use the latest issue of Standards.

1.07 Quality Assurance:

A. Qualification:

1. Work of this section to be carried out by an approved fabricator/installer of the material/product supplier. The fabricator / installer to possess a minimum of 5 years proven experience in this type of work.

B. Qualification of welders – Use only welders certified by the competent authority for the work of this Section.

PART 2 - PRODUCTS

2.01 Materials and Fabrication:

A. Provide hatches entirely fabricated of 316 L stainless steel.

B. Access Covers:

1. Furnish and install where indicated on the Drawings complete access hatches of required sizes. All access hatches shall be double-leaf completely pre-assembled from the manufacturer.

2. Chequered plate shall be 6 mm thick diamond pattern.

3. Chequered plate to support a minimum live load of 1464 kg/m^2 with a maximum deflection of 1/150^{th} of the span.

4. Operation of the access hatch to be smooth and easy with controlled operation throughout the entire arc of opening and closing.

5. Operation of the access hatch shall not be affected by temperature.

C. Frame: Continuous four sided ‘L’ shaped frame with flush edges, 6 mm thick with ’L’ shaped anchors around the perimeter at 450 mm c/c.

D. Hardware:

1. Hinges: 5 mm thick x 100 wide heavy duty, designed for horizontal installation and through-bolted to the cover and frame with tamperproof type 316 stainless steel lock bolts and locknuts. Provide a 9.5 mm diameter pin with oversized domed ends.

2. Lifting Mechanisms: Provide the required number and size of compression spring operators enclosed in telescopic tubes to provide, smooth, easy and controlled cover operation throughout the entire arc of opening and to act as a check in retarding downward motion of the cover when closing. The upper tube shall be the outer tube to prevent accumulation of moisture, grit and debris inside the lower tube assembly. The lower tube shall interlock with a flanged support shoe fastened to a formed 6 mm thick gusset support plate.

3. A removable exterior turnkey lift handle with a spring-loaded ball detent shall be provided to open the cover and the latch release to be protected by a flush, gasketed, removable screw plug. A Type 316 stainless steel snap lock with fixed handle shall be mounted on the underside of the cover for emergency use.

4. Cover shall be equipped with a hold-open arm which automatically locks the cover in the open position.

E. Finishes:

1. Frames: Smooth mill finish.

2. Top of chequered plate: Lightly polished.

2.02 Approved Manufacturer:

A. All exterior and interior hatches shall be:

1. West Coast Engineering Pvt. Ltd
2. Bilco
3. or equivalent as approved.

PART 3 - EXECUTION

3.01 Installation:

A. Verify that the installation will not disrupt other works. Verify that the substrate is dry, clean and free of foreign matter. Report and correct defects prior to any installation.

B. Hatches shall be installed in accordance with manufacturer's instructions.

C. Check the supplied product and verify the manufacturer's details for accuracy to fit the application prior to fabrication.

D. Furnish mechanical fasteners consistent with hatch manufacturer's instructions.

E. Installed hatches shall operate smoothly, consistently without warpage or buckling.

F. Manufacturer's representative shall inspect completed hatch to ensure that installation is in accordance with manufacturer's requirements and these Specifications.

END OF SECTION 05560.

SECTION 05561 STAINLESS STEEL CHEQUERED PLATE

PART 1 -GENERAL

1.01 Reference:

A. Section 05000 - applies to and governs the work of this Section.

1.02 Work Included:

A. Design, fabricate, supply and install 6mm thick grade 316 stainless steel diamond pattern chequered plates as shown on the Drawings.

B. Comply with all pertinent requirements of Section 05500 - Including installation.

C. The Drawings, Datasheets and Specifications are intended to set the acceptable minimum standard.

1.03 Related Work:

A. The following related work is covered elsewhere in the Contract documents:

1.	Concrete	-	Division 3
2.	Section 05120	-	Structural steel
3.	Section 05520	-	Misc. Metals
4.	Division 11	-	Equipment

1.04 Alternatives:

A. Not applicable for this Section.

1.05 Submittals:

A. Submit shop drawings and shop profiles of all products prior to fabrication in accordance with Section 01007 and As-Built drawings as per Section – 01016.

B. Provide samples representative of the materials and accessories.

1.06 Codes and Standards:

A. The following applicable standards established by the Bureau of Indian Standards govern the materials and workmanship for the work under this Section.

1	IS 6911	Stainless steel sheet and strip.
2	IS 12817	Specifications for stainless steel butt hinges.
3	IS 3502	Steel chequered plate.

Where provisions of the pertinent codes and standards conflict with these Specifications and Drawings or with each other comply with the more stringent provisions.

B. Use the latest issue of Standards.

1.07 Quality Assurance:

A. Qualification:

1. Work of this section to be carried out by an approved fabricator/installer of the material/product supplier. The fabricator / installer to possess a minimum of five years proven experience in this type of work.

B. Qualification of welders – Use only welders certified by a competent authority.

PART 2 - PRODUCTS

2.01 Materials and Fabrication:

A. Chequered Plate:

Grade 316 stainless steel with a raised diamond pattern or alternative acceptable pattern with a minimum thickness of 6mm, cut in easy-to-handle sections. Reinforce with welded ribs or angles as required to limit deflection to the lesser of 4mm or 1/200 of the shorter span under a concentrated load of 1.1 kN at the centre. Where concrete support is not provided to the edge of the chequered plate panel, provide additional framing.

B. For gas-tight applications, provide a continuous neoprene gasket around the perimeter of the cover plate and the cover shall be bolted down.

C. Provide hinges, locks and other items as required. Panels with hinges shall be complete with lift handles and hold-open arms. Hinges shall be heavy duty of the concealed type made of stainless steel. Hold-open arms shall be stainless steel.

D. Covers without hinges shall have two lifting handles per panel or holes of suitable size for lifting.

E. Stainless steel chequered plate shall be installed to pipe channels, pump area and other areas shown on the Drawings.

F. Finishes:

1. Frames: smooth mill finish.
2. Top of Chequered Plate: Lightly polished, diamond pattern or other pattern acceptable to the Engineer.

2.02 Approved Manufacturer:

A. All exterior and interior chequered plate shall be:

1. West Coast Engineering Pvt. Ltd,
2. Or equivalent as approved.

PART 3 - EXECUTION

3.01 Installation:

A. Install chequered plate flush with the floor, free of warpage and in a manner to show a continuous uniform appearance.

B. For stainless steel chequered plate over pipe trenches, provide a hinged section behind every side opening.

C. For opening the inspection cover provide handles flush to the floor.

D. Manufacturer's representative shall inspect completed chequered plate to ensure that installation is in accordance with manufacturer’s requirements and these specifications.

END OF SECTION 05561.

SECTION 05562 GALVANIZED IRON CHEQUERED PLATE

PART 1 -GENERAL

1.01 Reference:

A. Section 05000 - applies to and governs the work of this Section.

1.02 Work Included:

A. Design, fabricate, supply and install 6mm thick Galvanized Iron diamond pattern chequered plates as shown on the Drawings.

B. Comply with all pertinent requirements of Section 05500 - Including installation.

C. The Drawings, Datasheets and Specifications are intended to set the acceptable minimum standard.

1.03 Related Work:

A. The following related work is covered elsewhere in the Contract documents:

1.	Division 3	-	Concrete
2.	Section 05120	-	Structural steel
3.	Section 05520	-	Misc. Metals
4.	Division 11	-	Equipment

1.04 Alternatives:

A. Not applicable for this Section.

1.05 Submittals:

A. Submit shop drawings and shop profiles of all products prior to fabrication in accordance with Section 01007 and As-Built drawings as per Section – 01016.

B. Provide samples representative of the materials and accessories.

1.06 Codes and Standards:

A. The following applicable standards established by the Bureau of Indian Standards govern the materials and workmanship for the work under this Section.

1	IS 6159	Recommended practice for design and fabrication of Iron & Steel product prior to galvanizing and metal spraying.
2	IS 2629	Recommended practice for hot dip galvanizing of Iron and Steel.

Where provisions of the pertinent codes and standards conflict with these Specifications and Drawings or with each other comply with the more stringent provisions.

B. Use the latest issue of Standards.

1.07 Quality Assurance:

A. Qualification:

1. Work of this section to be carried out by an approved fabricator/installer of the material/product supplier. The fabricator / installer to possess a minimum of five years proven experience in this type of work.

B. Qualification of welders – Use only welders certified by a competent authority.

PART 2 - PRODUCTS

2.01 Materials and Fabrication:

A. Chequered Plate:

Galvanized Iron with a raised diamond pattern or alternative acceptable pattern with a minimum thickness of 6mm, cut in easy-to-handle sections. Reinforce with welded ribs or angles as required to limit deflection to the lesser of 4mm or 1/200 of the shorter span under a concentrated load of 1.1 kN at the centre. Where concrete support is not provided to the edge of the chequered plate panel, provide additional framing.

B. For gas-tight applications, provide a continuous neoprene gasket around the perimeter of the cover plate and the cover shall be bolted down.

C. Provide hinges, locks and other items as required. Panels with hinges shall be complete with lift handles and hold-open arms. Hinges shall be heavy duty of the concealed type made of G.I. Hold-open arms shall be G.I.

D. Covers without hinges shall have two lifting handles per panel or holes of suitable size for lifting.

E. G.I. chequered plate shall be installed at locations as shown on the Drawings.

F. Finishes:

1. Frames: smooth mill finish.
2. Top of Chequered Plate: Lightly polished, diamond pattern or other pattern acceptable to the Engineer.
3. Repair galvanized coating, damaged during transport or erection, in accordance with I.S. Code using Zine-rich paints. Dry film thickness on repairs shall exceed the original coating thinness by 25%.

PART 3 - EXECUTION

3.01 Installation:

A. Install chequered plate flush with the floor, free of warpage and in a manner to show a continuous uniform appearance.

B. For G.I. chequered plate over pipe trenches, provide a hinged section behind every side opening.

C. For opening the inspection cover provide handles flush to the floor.

D. Manufacturer's representative shall inspect completed chequered plate to ensure that installation is in accordance with manufacturer’s requirements and these specifications.

END OF SECTION 05562.

SECTION 08000 METAL DOORS AND WINDOWS

PART 1 -GENERAL

1.01 Governing Conditions

A. The General Conditions, Particular Conditions, Contract Forms, Instruction to Contractor, and the requirements of Division 1 herein before specified, in addition to any and all Addenda, apply to and govern each Section of this Division.

B. This Section covers the general requirements for this Division and shall be read in conjunction with all other Sections in this Division.

C. This Section governs the work of all other Sections in this Division.

1.02 Work Included:

A. The work in general shall consist of supplying assembling and/or erecting and installing of all doors, windows, ventilators, louvers, rolling shutters, glazed partitions, etc. as required with all materials complete including supply and fixing of glass and glazing.

1. Supply, deliver, fabricate, install and warrant the works in strict compliance with the materials and workmanship requirements of the Technical Specification as per site conditions.
2. Where required to prepare drawings these shall be limited to final detailing of components and systems indicated on the Design Drawings, necessary to demonstrate their safe installation.
3. Where alternative products are offered by the Contractor for acceptance by the Engineer, provide full supporting documentation in respect of the complete system or installation, including its value engineering proposals.

1.03 Co-ordination:

A. Co-ordinate with the work of other Divisions before commencing fabricating and installing work included in this Division. If work is installed without co-ordination with other works, the Engineer may direct that such work be removed, relocated and/or modified as necessary. Comply promptly with any Engineer's requests. Complete any correction and/or additional work.

B. For coordination requirements refer to Section 01002.

1.04 Submittals:

A. Submit shop drawings, product data, and other documents for doors, frames, windows, screens, window walls, panels, ironmongery and special items as required, not limited to following, in accordance with Section 01007:

1. Detailed Technical Specifications
2. Product Data Sheets
3. Detailed shop drawings and erection drawings clearly showing thickness of metals, construction details, attachments and reinforcing for ironmongery and other pertinent information.
4. Submit samples of all items as indicated in the Sections enclosed herein.

B. Refer to individual Sections of this Division.

C. Neatly assemble and submit product data containing booklets, drawings, instruction sheets etc issued by the suppliers and As-Built drawings in accordance with Section 01016.

1.05 Codes and Standards:

A. The following applicable standards established by the Bureau of Indian Standards govern the materials and workmanship for the work under this Division:

1.	IS:2835	-Flat Transparent sheet glass
2.	IS:4351	-Steel door frames
3.	IS:1038	-Steel doors, windows and ventilators
4.	IS:1361	-Steel windows for industrial buildings
5.	IS:1081	-Code of practice for fixing and glazing of metal (Steel & aluminium) doors, windows and ventilators.
6.	IS:1477	-Code of practice for painting of ferrous metals in buildings and allied finishes (Part I & III)
7.	IS:1948	-Aluminium doors, windows and ventilators
8.	IS:1949	-Aluminium windows for industrial buildings
9.	IS:3548	-Code of practice for glazing in buildings
10.	IS:6248	-Metal Rolling Shutters and Rolling grills
11.	I.S. 204	-(Part I) Specification for tower bolts (ferrous metal)
12.	I.S. 204	-(Part II) Specification for tower bolt (non ferrous metal)
13.	I.S. 208	-Specification for door handles
14.	I.S. 723	-Specification for steel countersunk head wire nails.
15.	I.S. 848	-Specification for synthetic resign adhesives for plywood.
16.	I.S. 1341	-Specification for steel butt hinges.
17.	I.S. 1659	-Specification for block boards.
18.	I.S. 3564	-Specification for door closers.
19.	I.S. 4992	-Specification for door handles for mortice lock.
20.	I.S. 1081	-Code of practice for fixing and glazing of steel and aluminium doors, windows and ventilators.
21.	I.S. 4351	-Specification for steel door frames.

B. Where provisions of the pertinent codes and standards conflict with these Specifications, Drawings and Datasheets or with each other, comply with the more stringent provisions.

C. Use the latest issue of Standards.

PART 2 - PRODUCTS

2.01 Special Requirements:

A. Architectural and Functional

1. All door sets shall be certified to achieve the performance criteria purpose for which they are designed.

2. The components of the entire assembly shall be covered by a single source warranty. Therefore, approval shall be obtained from the manufacturer for all materials to be used.

3. The works shall be securely fixed and sealed in accordance with the manufacturer's recommendations, not compromising the performance and certification of the door set.

4. Fittings and Fixtures / Ironmongery /operating mechanisms:

   – Fittings and Fixtures / Ironmongery shall be as specified. The door set manufacturer shall ensure that the ironmongery does not compromise the certification of the works.
   – For sliding door the sliding gear shall be integrated as indicated on the Design Drawings.
   – Refer to the Door Schedule, Services Engineer's documentation and the Fire Strategy Report with regard to door operations, security and additional devices, etc.

5. Concealed wire ways shall be allowed for connection to equipment within the framing system, back to the building power supply and Building Management System (BMS), etc. Co-ordinate provisions for electrical services and sensing devices and final connections. Connect all parts of equipment with insulated wiring as required for operation.

   – Locations/ positioning of services shall be agreed with the Engineer where not indicated on the Design Drawings.
   – Provide all necessary seals, gaskets and support framing etc. where services penetrate or interface with the other works.

6. Where glazing is specified, the glass thickness, type, make-up, risk of breakage and containment in the various locations shall be determined, taking full regard for the safety requirements.

7. All door sets shall be checked with regards to security and the relevant security symbols.

8. Fixing of signage shall be undertaken by methods that do not compromise with the performance and integrity of the door sets.

9. Door sets shall be factory pre-machined, and reinforced as necessary, for all specified ironmongery, prior to the application of factory finishes. Ensure that the door set manufacturer is in receipt of specimen furniture at the earliest opportunity after order placement to enable configurations of machinery.

10. The Contractor, in liaison with the manufacturer, shall ensure that the works as specified incorporate all necessary seals, sealants; fixings, accessories and ancillary items are supplied as required in accordance with and to achieve the requirements of the Technical Specification.

11. Door frames shall include integral or planted door stops that are within the frame profile, as accepted by the Engineer.

12. The method of installation of door frames to sub-frames, partitions or block work shall provide for seals and components to meet all performance requirements.

13. Fixings:

   – Fixings shall be concealed unless accepted otherwise by the Engineer.

- Provide and install all fixing devices, including framing, bearing brackets and movement fixings and carry out all necessary preparation work such as drilling, plugging, screwing, bolting, cutting for anchor bolts or sockets to be cast-in, making good, including grouting-in of anchor bolts and fixing in order to secure the works to supporting walls.

14. Pack any gaps between door frame and wall with suitable material to meet performance requirements.

15. Shadow gap detail between wall and frame shall be as indicated on the Design Drawings, where required.

16. Ensure that door leaf (ves) and associated panels arrive on site with adequate surface protection. Material used for surface protection shall be of low flammability.

B. Performance Requirements

1. Performance, as indicated on the associated Door Schedule, of the door set/ assembly type shall vary dependent on location. The Contractor shall use the applicable manufacturer's details of the required visual range to achieve the stated performance.

- Intumescent fire and brush smoke seals to suit fire and smoke ratings, as scheduled, shall be included.
- Acoustic seals to suit acoustic ratings, as scheduled, shall be included.

2. Industry recognised independent third party certification is required indicating compliance of individual door sets with the specified performance.

3. Ensure that all door sets are clearly marked on the hinge edge, with their door number and performance, enabling them to be reconciled with their intended location.

4. Door set components shall receive fire retardant treatments as required to satisfy the fire rating requirements.

5. Vision panels shall maintain the performance requirements of the door sets and shall be factory fitted.

6. Fire rated glass and associated beads, where required, shall be bedded in intumescent mastic in compliance with the manufacturer's performance certification.

2.02 Materials specification

A. Metal Finishes

1. All metal components shall be corrosion protected.

2. Visual Requirements

- Door and door set T-sheet references shall be common to doors of equivalent visual appearance. Variations in performance requirements, dimensions, configurations (i.e. single leaf, leaf and a half, double leaf) and structural opening dimensions shall be as stated on the Door Schedule and as indicated on the Design Drawings.
- Arrangement and configuration of door sets and the inclusion of any additional requirements, such as but not limited to, vision panels, louvers, door protection, in excess of the standard door blank, shall be as stated on the Door Schedule and/ or the Design Drawings.

- Finishes shall be as indicated on the Door Schedule and/ or the Design Drawings, preparation for which shall be in accordance with the doorset and finishes product/ material manufacturer's recommendations and, where applicable, the Technical Specification.
- Dimensions and profiles of doors and frames indicated on the Door Schedule and/ or Design Drawings are nominal and indicative of the design intent. The Contractor shall maintain these dimensions and clearly state them on the Working Drawings. Any deviations to the indicated dimensions shall be stated with the return of Tender Document.
- Vision panels shall be, unless otherwise stated, clear, unwired, Kite marked safety glass in accordance with relevant standards and regulations.
- Where fire resisting glass is required, comply with the specified fire ratings and ensure that framing, beadings and gaskets are suitable for the fire rating to be achieved.
- Beading, for vision panels, shall be a species of hardwood to match the facing of the door set and shall be accepted by the Engineer through sampling

2.03 Metal Doors and Windows

A. Steel Doors and Windows

- Steel section used for fabrication of doors, windows etc. shall be standard rolled steel sections specified in IS: 1038 and IS: 1361 or as specified in drawing and schedules.

- Steel sheets for frames, shutters, louvers blades etc. shall be of a gauge mentioned in drawings and schedules.
  - Door Frames

  - Frames shall be fabricated from 16 G sheets. They shall be mortised, reinforced, drilled and tapped for hinges and lock and bolt strikes. Where necessary, frames shall be reinforced for door closers; Welded Construction with mitred corners shall be used. Rubber door silencers shall be furnished for the striking jamb. Loose "T" masonry anchors shall be provided.
  - Frames shall finish flush with floor and adjustable floor anchors shall be supplied. Frames shall be brought to site with floor ties/weather bars installed in place.

B. Aluminium Doors and Windows

Aluminium sections for fabricating doors, windows, partitions etc. shall be extruded sections conforming to IS: 1948 and 1949 or as manufactured by approved manufacturer. The alloy used shall conform to IS Designation HE 9-WP of IS : 733.

The mastic for caulking shall be of best quality from a manufacturer approved by the Engineer. In general, the mastic for fixing of metal frames shall be as per IS:1081 and/or as approved by the Engineer.

- Manufacturer
  - Reference(s) as required to suit the scheduled performance criteria:
- Frames:

- Galvanised steel as recommended by the door set manufacturer, of suitable thickness, to achieve the requirements of the Technical Specification.
- Frames shall be profiled as indicated on the Design Drawings.
- Frames shall be supplied with mitred and welded corners providing a clean smooth finish.
- All mullions shall be minimum 50mm wide.

- Leaves:
  - Core from the manufacturer's range to achieve the requirements of the Technical Specification.
  - Facings shall be formed from two skins of galvanised sheet steel of suitable thickness, and with no face seams. Face skins shall be connected by a continuous interlocking edge lock seam associated with the specified product.
  - Door edges shall be bevelled.
- Finishes, refer to the Door Schedule:
  - Paint finished, colour to the acceptance of the Engineer through sampling.
  - Finishes shall be undertaken in accordance with the manufacturer's recommendations and subject to acceptance by the Engineer through sampling.

C. Doors with Specific Requirements

The Contractor shall supply and install doors and windows along with glazing, Aluminium Composite panels, louvers, SS mesh, vision panel etc. as specified in the drawings.

All the doors in the Laboratory building shall be air tight.

D. Sound Insulated Doors

Sound insulated doors shall be supplied by manufacturers. The doors shall be made from 16 g. M S sheets sandwiched with 50 mm thick insulation. Sturdy hinges of shaft and barrel type shall be provided to withstand heavy and repeated industrial use. Sealing gasket shall be provided all round the door frame. The arrangement of the gasket shall be such as to allow easy replacement. The handles shall be made of brass and chromium plated. The design of handles shall be such as to ensure effective sealing. Alternatively design drawings will be furnished by the Contractor for the fabrication, and fixing the door.

E. Fire Check Doors

The Fire Check Doors shall be plate type, complete with door frames etc. made with 6 mm thick MS plate, angles & flats. Styles shall be riveted. These doors shall be supplied by approved manufacturer and shall be as per IS: 3614 (Part II). Alternatively design drawings will be furnished by the Contractor including fabrication drawing for the approval of Engineer.

Where ever specified in the drawing Fire Check Doors made of timber shall be supplied in accordance with IS 3614 part II.

F. Press Steel Doors

Generally all steel doors shall be standardized flush type or as specified and shall be supplied by the approved steel manufacturers, properly machine welded, adequately stiffened and prepared for all hardware attachments including fixing, fixtures, and fittings as specified in the drawing. The Contractor shall submit shop drawings for all types of steel doors, for approval of Engineer.

Fabrication of door shall be commenced only after the drawings are approved. The shop drawing shall indicate all dimensions, details of fabrication, the gauge of the sheets, stiffeners, reinforcing anchorages, installation and other works required for complete installation.

The Contractor should get the fabrication work from some established and good firm. The name of the firm shall be informed to Engineer for his approval.

A sample of each type of finished door complete with fittings and fixtures shall be submitted for approval of the Engineer. Sample shall be the property of the Contractor.

- Single Plate Door Shutters

  Single sheet doors shall be made from best quality 18g mild steel sheets, and shall present a flush surface on the outside. The inside shall be stiffened with semi tubular edge and central stiffening rail which shall hold the lock and other furniture. The frames shall be made from best quality 16g mild steel sheets. Wherever required, provisions for fixing glass panes, louvers etc. shall be made.

- Double Plate Door Shutters

  Door shutters shall be 45mm thick, completely flush design and shall comprise of two outer 16 G steel sheets rigidly connected and reinforced inside with continuous vertical 16 G stiffeners, spot welded in position at not more than 150mm on centres.

- Sliding doors

  The Sliding Doors shall be either double plate or single plate construction, as shown in schedules. It shall be made out of 18 gauge steel sheets with adequate stiffeners. The Contractor shall specify the weight of the door in his shop drawing and submit the manufacturer's catalogue of the sliding gear he proposes to use. Where shown on drawings or called for in the Schedule of Items, the Contractor shall make provisions for openings in the door for monorail beams etc. Doors shall close positively to exclude rain water from seeping in. When called for in schedule, sliding doors shall withstand specified wind loads without buckling of jamming. The door shall slide freely under all ambient conditions.

- Door Threshold

  Door thresholds shall be provided. Door without threshold shall have bottom tie of approved type.

PART 3 - EXECUTION

3.01 Fabrication of Metal Doors

A. The pressed steel frames and shutter shall be fabricated with CRCA steel sheets of different gauges as indicated in relevant drawings and as specified in the item of Tender.

B. The shutter frame and stiffeners shall be fabricated with standard M. S. sections. The rebates in the door frames shall have sharp right angle corners.

C. All the joints shall be continuously reinforced at the back, fitted and continuously welded along the abutting edges.

D. For installing the pressed steel frames against the concrete like R.C.C. columns, lintels, walls etc. the hold fasts shall be welded to reinforcements or anchor plates provided in the concrete members and the pockets shall be grouted with cement concrete of strength specified for the concrete member.

E. The pressed sheet of steel frames for opening wider then one metre shall be properly reinforced to prevent sagging. Necessary reinforcement for attaching different hardware's shall be provided and frames and shutters shall be cut and suitably stiffened with steel plates to suit the hardware template for securing butts, strikes checks and other hardware.

F. Necessary hardware fittings and fixtures such as butt hinges, mortice lock with handles, tower bolts, etc. shall be supply, fixed by Contractor.

G. All hardware items shall be fixed in a good workmanlike manner with requisite galvanized M. S. counter sunk machine screws or as specified and directed by the Engineer.

H. The Contractor shall also see properly that the stains, grease, rust etc. is thoroughly removed before application of one coat of steel primer.

I. All the steel doors shall be approved by the Engineer before shop painting work is undertaken.

J. Suitable neoprene linings shall be provided around the frames as well as on intermediate hinge lines and meeting styles to make the doors perfectly airtight.

3.02 Fabrication of Aluminium Doors

A. Extruded sections shall have a minimum 3mm wall thickness. All sections shall be approved by the Engineer before fabrication is taken up. Doors, frames mullions, transomes etc. shall be anodized in bath of sulphuric acid to provide a clear coating. The anodized materials shall then be sealed by immersing in boiling water for 15 minutes. A protective transparent coating shall be applied to the sections before shipment from the factory.

B. All work shall be fitted and shop assembled to a first class job, and ready for erection. Shop joints shall be made to hair lines and then welded or braced by such method as will produce a uniform colour throughout the work. Work on the above, other than described, shall be carefully fitted and assembled with neat joints with concealed fasteners. Whenever possible, joints shall be made in concealed locations and on edges of doors. Field connections of all work may be made with concealed screws or other approved type of fasteners. Glazing beads shall be snap fit type without visible screws and shall be of sizes to accommodate 6mm thick glazing. All work shall be adequately braced and reinforced as necessary for strength and rigidity.

3.03 Fabrication Tolerance

A. The Working Drawings shall provide for sufficient tolerance in manufacture of the works in order to accommodate manufacturing tolerances of interfacing elements.

B. Full details shall be submitted to the Engineer for review of the proposed methods for achieving and constantly monitoring the tolerances during all stages of the work. Detailed records of the constant control and tolerances achieved shall be submitted to the Engineer.

3.04 Tolerances for Manufacture

A. **Assembly:** The physical fitting together of any assembly of sub-elements shall be properly allowed for in the Detailed Design of the corresponding sub-elements.

B. The following tolerances apply to each individual component:

1. Length/ Width: Maximum allowed deviation is the lesser of 1.5mm up to 2000mm and 2.0mm above 2000mm of design dimension.

2. Thickness/ Depth (extrusion tolerances nominally): Maximum allowed deviation is ±0.5mm.

3.05 Workmanship

A. During construction, exposed components shall be protected after fitting and care taken to avoid fitting any components whilst 'wet' trades are still in progress. Protect from abrasives, acids and other corrosive materials.

B. Installation of Fire Check Door sets shall be carried out by sub-contractors who are members of a nationally recognised quality assurance scheme, and ideally the same scheme to which the door manufacturer subscribes.

C. Installation of Fire Check Door sets shall be in accordance with the recommendations of the Architectural and Specialist Door Manufacturer's Association Installation Guide.

1. Protection of Components

- Do not deliver to site components, which cannot be put immediately into suitable dry, covered storage with a dry floor. Stack on bearers, separated with spacers to prevent damage by and to projecting ironmongery, beads, etc.
- Protection of Components after Installation
- Ensure that all exposed components have protective coverings during storage and after installation to protect factory applied finishes. Door leaves shall also be protected during on-site operations.

2. Moisture Content

- All timber shall be subjected to controlled drying to ensure that the moisture content, if not otherwise specified, is suitable for the situation of the finished joinery. When fixed it shall remain stable and free from expansion, contraction or other movements detracting from the required performance or appearance.
- During delivery, storage, fixing and thereafter till handing over, maintain conditions of temperature and humidity to suit the specified moisture content(s) of timber components. When instructed by the Engineer, test components with accepted electrical moisture meter used in accordance with the manufacturer's recommendations.

3.06 Ironmongery

A. Assemble and fix carefully and accurately using fastenings with a matching finish supplied by the ironmongery manufacturer. Prevent damage to ironmongery and

adjacent surfaces. At completion check, adjust and lubricate as necessary to ensure correct functioning.

B. Doors and Windows shall be mortised, reinforced, drilled and tapped in shop for hinges, hooks and bolts. They shall also be reinforced for closers, push plates and other surface hardware where necessary. Any drilling and tapping required for surface hardware shall be done at site. Where shown in drawing, provision shall be made for fixing glazing, vision panels, louvers etc.

3.07 On-Site Dimensions

A. Implantation Contractor to take responsibility for all dimensions and for checking dimensions on site prior to manufacture.

B. Ensure that the Detailed Design accommodates any given tolerances and differences between actual site dimensions and dimensions shown on the Design Drawings.

3.08 Tolerances

A. Tolerances shall be measured against the relevant Base Reference Datum; Location Reference Point; Location Reference Plane; Location Reference Surface or Reference Element.

1. All elements shall be set out to their correct position as indicated on the Design Drawings and/ or Working Drawings, within ±2mm or 0.1% of the length, whichever is the lesser.
2. Vertical elements shall be plumb, within ±2mm or 0.1% of the height, whichever is the lesser.
3. Horizontal elements shall be level, within ±2mm or 0.1% of the length, whichever is the lesser.
4. The maximum variation in gap from a straightedge applied to a flat vertical plane shall be 2mm for a 3000mm straightedge and 1mm for a 1000mm straightedge.
5. The maximum variation in gap from a straightedge applied to a flat horizontal plane shall be 2mm for a 3000mm straightedge and 1mm for a 1000mm straightedge.
6. The maximum variation in gap from a straightedge applied to a flat inclined plane shall be 2mm for a 3000mm straightedge and 1mm for a 1000mm straightedge. Drainage requirements of inclined planes shall be maintained.
7. The maximum offset in plane, level or section between any two adjacent sections shall be ±1mm.
8. The average width of any panel to panel joint shall be within ±1mm of the nominal joint. Any variation shall be equally distributed with no sudden changes or steps.
9. The maximum deviation between adjacent tile/ panel surfaces either side of an expressed joint shall be 1mm.
10. The bow of any flat surface shall not exceed more than ±2mm from a 2000mm straightedge placed against it in any direction.
11. The straightness of any surface of an edge shall not deviate by more than ±2mm from a
12. 2000mm straightedge placed against it in any direction parallel to the long axis of the element.

13. The centre section of any lineal element shall not bow by more than the lesser of ±2mm or 0.075% of the length of the element measured from a straight line between the ends of the element.

14. The cross-section of any element shall not be twisted by more than 1° from the intended alignment.

15. Dimensional and location tolerances of cut-outs for interfacing works shall be ±1mm the dimensions indicated on the Design Drawings. The Contractor shall verify, with the appropriate supplier/ trade Contractor, that such dimensions and locations are correct. Any deviation shall be agreed with the Engineer.

16. Account shall be taken of the installation tolerance requirements such that repetitive elements are accurately located, relative to gridlines.

17. Tolerances shall not be cumulative. The most onerous tolerance shall apply.

3.09 Installation Tolerances

A. Gaps to head and jambs of doors to frames shall be consistent, of minimal dimensions and shall maintain the performance and functional requirements of the door(s).

B. The gap at the threshold of a door shall provide a nominal 3mm clearance above the finished floor level.

C. The maximum variation from plumb shall be ± 1.5mm.

D. Cut-outs for interfacing works shall be to the dimensions shown on the Working Drawings ±1mm.

E. Horizontal Plan Position: For any element at any level whose position is defined in relation to a primary reference grid, the maximum allowed deviation from the Design Dimension to that reference grid is ±2mm.

F. Where a series of doors is arranged in an array of two or more, the maximum allowed deviation of the horizontal distance between any two adjacent elements is ±2mm from the corresponding Design Dimension.

G. Planarity: Any door whose position is defined from a reference plane shall not deviate from the Design Dimension of the reference plane by more than ±2mm measuring perpendicular to the defined plane.

H. The width of any joint shall not deviate from the nominal width by more than ±1mm of the joint width. Any variation shall be equally distributed with no sudden changes. The misalignment between joints shall not exceed 1mm.

I. Line and level shall be within ±2mm of the specified level.

J. The works shall be erected such that no point on any part is more than 1mm from its theoretical plane.

K. The dimensional and detailed provisions intended to accommodate the construction tolerances of surrounding elements in order to ensure that all aspects of the works relate satisfactorily to the works as a whole shall be stated and shown on the Working Drawings.

L. All tolerances stated shall be measured and monitored at a mean temperature to be agreed with the Engineer.

M. Before work begins on site the proposed method of dimensional setting-out and cross-checking with adjacent trades and elements, to satisfy the accuracy requirements, shall be submitted to the Engineer. The checking of any setting-out or

of any line or level by the Engineer, or his representative, shall not in any way relieve the Contractor of his responsibility for the correctness thereof.

N. Alternative tolerances to those specified may be permitted at the Engineer's discretion, provided they are agreed in advance of the manufacture of components.

O. Tolerances shall not be cumulative.

3.10 Shop Coat of Paint

A. The shop paint for rolling shutter, steel doors / windows etc. shall be best red oxide or zinc chromate primer paint from approved manufacturer. All surfaces shall be thoroughly cleaned of rust, grease, loose mill scales etc. and given one coat of shop paint. Portions like mullions, transoms etc. which will be inaccessible after assembly of units shall be given an extra coat of paint before assembly.

B. Where called for in the Schedule of Items, all steel doors, Windows etc. shall be hot dip galvanized to give a coating weight of 1.5 to 2 oz. per sq. feet. One coat zinc chromate primer coat shall then be applied as shop paint.

C. Portions of aluminium frame which come in contact with masonry construction, shall, before shipment from workshop, be protected with a heavy coat of alkali resistant paint. Aluminium coming in contact with other incompatible metals shall be coated with zinc chromate primer.

3.11 Steel Windows, Aluminium Windows, Ventilators, Louvers

A. These shall conform in all respects to IS:1038 and IS:1361 latest editions. The details as called for in the above codes shall be applicable for coupling mullions, transoms, weather bars, pivot arrangements for ventilators, etc. or called for in the Schedule of Items.

B. All welds shall be dressed flush on all exposed and contact surfaces. Where composite unit openings are shown on drawings, the individual window units shall be joined together with requisite transoms and mullions. All windows shall be outside glazed, fixed with putty or metal glazing beads and/or specified under Schedule of Items.

C. Mouldings shall be of 18g steel or extruded aluminium sections with profiles shown in drawing and suitable for fixing glass. Louvers blades shall be V or Z shaped and made out of 16g sheets.

D. Where aluminium beads are specified, they shall be extruded aluminium channel 9.5 mm x 9.5 mm x1.6 mm unless otherwise shown on drawings. Aluminium beads shall be given one coat of zinc chromate primer before fixing to windows. Both edges of doors / windows shall be jointed and reinforced full height by steel channels placed immediately inside and welded to the doors / window faces. Top and Bottom of doors / windows shall be reinforced horizontally by steel channels running full width of window. Doors / windows shall not have more than 2.5 mm clearance at jambs and heads shall have proper bevel on lock stiles and rails to operate without binding, and shall be reinforced at corners to prevent sagging or twisting. Pairs or double doors / windows shall have meeting stile edges bevelled or rebated. Where shown or drawing, or called for in the schedule of items, the doors / windows shall be sound insulated by filling the inside voids with mineral wool or other suitable approved materials.

END OF SECTION -08000.

SECTION 08360 GI ROLLING SHUTTERS

PART 1 -GENERAL

1.01 Reference:

A. Section 08000 applies to and govern the work of this Section.

1.02 Work Included:

A. Design, supply and installation of rolling shutter doors complete with fitting accessories and motorized automation system.

B. Supply and installation of all appurtenances associated with the above for complete working systems.

C. The Drawings, Datasheets and Specifications are intended to set the acceptable minimum standard. Ensure that the installed equipment is trouble-free and meets performance requirements.

1.03 Related Work:

A. The following related work is covered elsewhere in the Contract Documents:

1. Division 4 - Masonry
2. Division 9 - Finishes - Painting
3. Division 16 - Electrical

1.04 Alternatives

A. Not applicable for this Section.

1.05 Submittals:

A. Submit shop drawings and Product Data, documents as specified in Section 08000 in accordance with Section 01007 and As-Built drawings as per Section 01016.

1.06 Code and Standards:

A. The following applicable standards established by the Bureau of Indian Standards govern the materials and workmanship for the work under this Section.

1		National Building Code of India, 2005
2	IS 6248: 1979	Metal Rolling Shutters and Grilles.

B. Where provisions of the pertinent codes and standards conflict with these Specifications, Drawings and Datasheets or with each other, comply with the more stringent provisions.

C. Use the latest issue of Standards.

PART 2 - PRODUCTS

2.01 General:

A. Design Requirements:

1. Wind Loading: Supply doors to withstand up to 6 kg/m^2 wind load.
2. Cycle Life: Design doors of standard construction for normal use of up to 20 cycles per day.

B. Where door opening areas are 5 m^2 or greater, provide an electrical actuated door system.

2.02 Materials:

A. General:

1. Rolling shutter shall be of the size to suit the openings and shall be positioned at the entrance of the dry well to carry out maintenance activity and/or as directed by the Engineer.

2. The rolling shutter shall be fabricated from 0.9 mm thick steel for shutters up to 3.5m width and 1.2mm thick sheet for shutters over 3.5m width. The shutter shall be rolled with lath sections of effective bridge depth 12mm at 75mm rolling centres, interlocked with each other and ends locked with malleable cast iron or mild clips. The guide shall either be rolled or pressed deep channel sections, fitted with necessary fittings and fixtures. The width of the channel shall be 25 mm and the depth 75mm up to 8 M wide shutter. The depth shall be 100 mm for shutters above 8 M width.

3. The hood covers shall be made of 18 gauge G.I sheets with necessary stiffeners and frame work to prevent sag. The bottom lock plate shall be made of 3mm thick M.S. plate and 95 mm wide reinforced with angle iron of suitable section with 6mm dia. M.S rivets interlocked with stride of curtain. Where grills are specified in the drawings , shall be fabricated from 8 mm dia round / square bars with supporting frames , clips etc to allow free vertical movement of the shutter .

4. Unless otherwise specified for overall area of rolling shutters up to $8m^2$ pull and push type hand operated shutters shall be used. For area between 8 and $10m^2$, push and pull type shutters shall be provided with ball bearings.

5. For area larger than $10m^2$ mechanical gear type or electrically operated shutters shall be used. Operation of shutters shall be by means of worm and worm wheel and shaft arrangement and it shall be possible to operate the door either from inside or from outside. The shutter shall be capable of withstanding horizontal forces up to 100 kg/m² without any appreciable deflection.

B. Handling & Storage of Fabricated Materials

1. All doors windows, etc. shall be packed and crated properly before despatch, to ensure that there will be no damage to the fabricated materials. Loading into wagons and trucks shall be done with all care to ensure safe arrival of materials at site in undamaged condition.

2. When taking delivery of items supplied by Employer, the Contractor shall satisfy himself that the items supplied are up to the specified standard. Any defect detected shall promptly be brought to the notice of the Engineer. All doors, widows etc. shall be stored under cover in a way to prevent damage or distortion. Special care shall be taken to prevent staining of aluminium products by rust, mortar etc.

2.03 Approved supplier / Manufacturer

A. Supplier /Manufacturer meeting required specification.

PART 3 - EXECUTION

3.01 General:

A. Inspect all parts as soon as they arrive on site and report any damage to the Engineer.

B. Have the door supplier carefully inspect and verify that substrate details and location are acceptable before installation of the doors commences.

C. Install all door components as per manufacturer’s instructions.

D. Upon completion of installation, operate all doors to ensure smooth operation and no jamming occurs during raising or lowering operations. Make all adjustments necessary for the door's smooth operation. Ensure door operates as required under electrically actuated and manual operation.

E. Clean soiled surfaces as recommended by manufacturer.

F. Remove surplus materials and debris from the site.

G. Instruct the operators in the complete operation of the doors.

H. Instruct the operators regarding maintenance procedures.

PART 4 -SPECIFICATIONS FOR ROLLING SHUTTERS

4.01 `General

A. Rolling shutters complete with accessories shall be of approved quality and as specified. These shall be suitable for fixing in position as specified i.e. outside or inside; on or below lintel or between jambs of the opening. Rolling shutter shall be hand/gear operated as specified in the item of schedule of quantities. For hand operated shutters, it shall be push and pull type. For gear operated shutters, it shall be provided with reduction gear operated by mechanical device with chain, crank, shaft and handle. The shutter shall consist of 80 mm. wide m.s. laths 1.25 mm. thick or gauge as specified of best quality mild steel sheet machine rolled. Laths shall be inter locked together throughout their entire length and jointed together at the end with end locks. These shall be mounted on specially designed pipe shaft. The spring shall be of best quality and shall be manufactured from the tested tensile spring steel wire or strip of adequate strength to balance the shutter in all positions. The spring, pipe shaft etc. shall be supported on strong mild steel or malleable cast iron brackets. Both the side guides and bottom rails shall be joint less and of single piece of pressed steel of minimum 16 gauge thickness. The top cover of shaft, spring etc. shall be of the same materials as that of lath. No extra payment shall be made for the hood, brackets etc. to cover the shaft etc. The reduction gear arrangement operated by the mechanical device shall be of the best quality and shall be easy in operation.

4.02 Fixing

A. Brackets shall be fixed on the lintel/beam or under the lintel/beam as specified in item with rawl plugs and screws, bolts, washers etc. The shaft along with the spring shall then be fixed on the brackets. The lath portion (shutters) shall be laid on ground and the side guide channels shall be bound with it. The shutter shall then be placed in position. The side guide channels shall be fixed to the wall through the plates welded to the guides. These plates and brackets shall be fixed by means of steel screws, bolts and rawl plugs drilled into the wall. The plates and screws, bolts shall be concealed in plaster to make their locations invisible. Fixing shall be done accurately in a workman like manner that the operation of the shutter is easy and smooth. All grout holes and damages on the wall while fixing of shutters shall be made good by the contractor at no extra cost to the Department. The contractor shall ensure smooth and easy working of shutters. All the members of the rolling shutter shall be thoroughly cleaned off dust, scales, rust etc. and shall be given approved priming coat of red oxide paint before fixing the shutter in position and then shall be painted with two coats of flat/synthetic enamel paint of approved quality and shade.

4.03 Mode Of Measurement

A. The area of rolling shutters shall be measured in square metre correct up to two places of decimal. Width and height shall be taken for net opening correct to a centimeter. The rate shall include the cost of materials, labour involved in all the operations described above

END OF SECTION 08360.

SECTION 08410 ALUMINIUM WINDOWS

PART 1 -GENERAL

1.01 Reference:

A. Section 08000 applies to and governs the work of this Section.

1.02 Work Included:

A. Supply and installation of *aluminium* windows and windows with vents.

B. Glazing for all aluminium windows specified herein and in Section 08800.

C. Caulking and sealing of joints between framing members and at the perimeter of all aluminium members and adjacent materials as specified in Section 08000.

1.03 Related Work:

A. The following related work is covered elsewhere in the Contract Documents:

1.	Division 3	-	Concrete
2.	Division 4	-	Masonry
3.	Division 9	-	Finishes

1.04 Alternatives:

A. Not applicable for this Section.

1.05 Submittals:

A. Submit shop drawings, product data and other documents in accordance with Section 01007 and As-Built drawings as per section 1016.

B. Show details of construction, blocking, glazing, anchorage and other related work.

1.06 Codes and Standards:

A. The following applicable standards established by the Bureau of Indian Standards govern the materials and workmanship for the work under this Section:

1	IS:1948	Specification for aluminium door /windows and ventilators
2	IS:1081	Code of Practice for fixing and glazing of metal (steel and aluminium) doors, windows and ventilators.

B. Where provisions of the pertinent codes and standards conflict with these Specifications and Drawings or with each other comply with the more stringent provisions.

C. Use the latest issue of Standards.

PART 2 - PRODUCTS

2.01 General:

A. Specification is based on the following:

1. Aluminium frames: Series 516 for fixed sealed units and open-in vents with sealed units, 102 mm as approved by the Engineer.

B. Materials:

1. Aluminium members and panels: fabricated of 6063-T5 extrusion alloy.
2. Screws: stainless steel in exposed locations of same finish as aluminium frames.
    a) Clips and Anchor Straps: aluminium or stainless steel back-painted.
    b) Anchors: stainless steel.
    c) Setting Blocks and Shims: black neoprene rubber, conforming to IS 1081, Shore hardness: 80-90 for blocks, 40-60 for shims.
    d) Compression Gaskets: extruded neoprene, as approved by the Engineer
    e) Sealant:
        i. For glazing: one part acrylic tempolymer or other approved.
        ii. For caulking between framing members and other materials mastic or polysulphide compound.
    f) Glazing material: As per Section 08800.

C. Fabrication:

1. Fabricate units from extrusions of general size and shapes as per approved shop drawings and formed with clean, sharply defined profiles. Joints shall be accurately machined, assembled and sealed to provide neat weathertight joinery. Frame joints drawn and secured on assembly with corner joint brackets and stainless steel screws or welded or concealed surfaces.
2. Fit and assemble work in the workshop, where possible. Execute work in accordance with details and approved shop drawings. Assembled units shall be square, true and correct in size and free of all defects or damage.
3. Seal joints before assembly.
4. Use and handle caulking compounds in accordance with the manufacturer's instructions.
5. Aluminium coming in contact with masonry, concrete or dissimilar metals shall be given a heavy coat of bitumastic paint to prevent electrolytic action.
6. Finish to all exposed aluminium: Colour: submit sample to Engineer for approval before fabrication. Colour to match windows on existing buildings if any. See Section 09900 for colour selection.

2.02 Approved Suppliers / Manufacturer of Aluminium Sections for Windows:

A. Hindalco Industries Ltd

B. Jindal Aluminium Ltd

C. or equivalent as approved.

PART 3 - EXECUTION

3.01 General:

A. Materials shall be delivered, handled and stored such that cracking, warping, deformation, discoloration and deterioration are prevented.

B. Mark the glass immediately after glazing to show its presence.

C. Remove temporary protection upon completion.

D. Frames and insulated sealed glazing units shall be free from moisture, dirt, cement, plaster, oil and grease.

E. Windows:

1. Centre glazing units using spacer shims and setting blocks, set at quarter points and at not more than 450 mm c/c.

2. Apply glazing tape to fixed leg of frame followed by needle bead of sealant. Set glazing units on setting blocks and press firmly into place against tape and sealant. Snap in glazing beads and press in compression gaskets. Mitre corners of vision strips.

3. Provide heel bead around perimeter of glazing units to give complete vapour seal.

3.02 Examination:

A. Examine job conditions before commencement of work.

B. Commencement of work will denote acceptance of existing conditions.

C. Rectify faults in the installed work to the satisfaction of the Engineer.

3.03 Erection:

A. Install, glaze and adjust windows using experienced workmen in accordance with the manufacturer's instructions and reviewed shop drawings. Set items in their correct locations, level, square, plumb and at proper elevations and alignment with other work.

B. Securely anchor members to structure.

C. Seal joints tightly to provide watertight installation.

D. Use concealed fastenings throughout.

3.04 Sealing:

A. Seal all joints between the work of this Section and adjoining work, to make the installation weather tight.

END OF SECTION 08410.

SECTION 08710 IRONMONGERY

PART 1 -GENERAL

1.01 Reference:

A. Section 08000 applies to and governs the work of this Section.

1.02 Work Included:

A. Supply and installation of all ironmongery and accessories and as specified herein or as required.

1.03 Related Work:

A. The following related work is covered elsewhere in the Contract Documents:

1.	Division 2	-	Site Work
2.	Division 3	-	Concrete
3.	Division 4	-	Masonry
4.	Section 08110	-	Hollow Metal Doors and Frames
5.	Section 08410	-	Aluminium Windows

1.04 Alternatives:

A. Not applicable for this Section.

1.05 Submittals:

A. Submit a comprehensive itemized schedule of ironmongery for each door and window for review in accordance with Section 01007 and As-Built drawings as per Section – 01016.

B. Include a complete list of ironmongery illustrations and manufacturers' data sheets literature, catalogues and samples.

1.06 Codes and Standards:

A. The applicable standards established by the Bureau of Indian Standards govern the materials and workmanship for the work of this Section.

B. Where provisions of the pertinent codes and standards conflict with these Specifications, Drawings and Datasheets or with each other, comply with the more stringent provisions.

C. Use the latest issue of Standards.

PART 2 -PRODUCTS

2.01 General:

A. Use stainless steel ironmongery, unless otherwise specified.

2.02 Keying:

A. Master key of all locks. Check with the Engineer with regard to master keying to the existing master key system.

2.03 Templates:

A. Deliver sufficient templates to enable door and frame manufacturers to fabricate and reinforce their materials to accommodate the respective ironmongery.

2.04 Hinges:

A. Supply 40 mm pairs, full mortised hinges for each door up to 2100 mm and two pairs of hinges for each door up to 4600 mm in height and three pairs of hinges for each door exceeding 4600 mm in height.

B. Hinges shall be as approved by the Engineer.

2.05 Locksets:

A. Locksets shall be heavy duty with satin, chrome finish. Lock cores - Multi-lock cores for master key system.

2.06 Latchsets:

A. Interior latchsets shall be Godrej or equivalent with standard duty series, Sat design, complete with strike. Latchsets shall have a satin, chrome finish.

2.07 Panic Device:

A. Panic devices for doors and fire doors shall be stainless steel rim type or equivalent subject to the approval of the Engineer.

2.08 Door Pulls:

A. Unless specified otherwise door pulls shall be stainless steel and subject to the approval of the Engineer.

2.09 Push Plates:

A. Unless specified otherwise push plates - stainless steel 125 mm x 500 mm.

2.10 Flush Door Bolts:

A. Unless specified otherwise for all double door systems, provide inactive leaf with a locking bolt, flush mounted in the door edge top and bottom, complete with strike plates. Mount bolts in the door edge flush so not visible when closed.

B. Unless specified otherwise, flush door bolts shall be stainless steel and subject to the approval of the Engineer..

2.11 Door Closers and Holders:

A. Supply brackets where necessary or recommended by the manufacturer.

B. Exterior doors: hold open arm as recommended by manufacturer .

2.12 Security Plates:

A. Stainless steel plates on exterior door locksets/padlocks.

2.13 Kickplates:

A. 3 mm x 200 mm height x door width less 40 mm stainless steel.

2.14 Door Jamb Strikes:

A. Stainless steel with extended lip.

2.15 Door Frame:

A. Weather-stripping integral with aluminium frame, as approved by Engineer.

2.16 Adjustable Door Sweeps:

A. Surface mounted CT-52: 23 x 48 mm x solid 3.1 mm neoprene- as approved by Engineer.

2.17 Padlocks:

A. Standard padlocks of approved make to suit the Engineer's Master Key system.

2.18 Approved Suppliers/Manufacturers:

A. Godrej, Mumbai

B. or equivalent as approved.

PART 3 - EXECUTION

3.01 Mounting Height for Ironmongery:

A. In general set at the following heights or as recommended by the manufacturer:

1	Panic Device	mount 1040 mm from finished floor to centreline of strike
2	Locksets, Latchsets	mount 990 mm from finished floor to centreline of strike
3	Padlocks:	mount 1040 mm from finished floor to centreline of strike
4	Door Pulls:	mount 1070 mm from finished door to centreline of pull
5	Push Plates:	mount 1220 mm from finished floor to centerline of plate
6	Hinges	mount upper edge of top hinge 130 mm below head of frame; locate lower edge of bottom hinge 250 mm above finished floor; space centre hinge equal distance between top and bottom hinges.

3.02 Mounting Hardware:

A. Hinges, Closers and Holders:

1. Install hinges, closers and holders on doors using stainless steel machine screws.

B. Kick-plates:

1. Fix kick-plates opposite hinge side with stainless steel screws, half domed heads. Set screws at close centres.

C. Thresholds:

1. Set aluminium door thresholds in a bed of sealant compound and bolt into lead shields in the flooring.

D. Door Closers:

1. Install door closers in such a manner that door opening is not obstructed.
2. Arrange door closers to suit the conditions with parallel arm application. Corner brackets are not acceptable.

E. Weather-stripping/Door Seals:

1. Install effectively to seal entire perimeter of doors, secure in place with stainless steel screws, in accurate alignment.
2. Maintain integrity of seals at head of doors fitted with closers. Adapt weather-stripping as required to achieve proper performance and provide necessary accessories.

F. Keys:

1. Cylinder faces and keys to have visual identification stamping.
2. Provide three keys per lock.

3.03 Adjustment:

A. Verify that installed ironmongery functions properly and ensure that it is adjusted accordingly to ensure satisfactory operation.

B. After installation, ensure finished ironmongery operates smoothly and without binding. Lubricate ironmongery in accordance with the manufacturer's recommendations.

3.04 Cleaning:

A. Clean ironmongery so that it is free of scale and surface blemishes.

END OF SECTION 08710.

SECTION 08800 GLAZING

PART 1 -GENERAL

1.01 Reference:

A. Section 08000 applies to and governs the work of this Section.

1.02 Work Included:

A. Supply and installation of glazing in doors and window walls.

B. Supply of all glazing products required for proper installation of the work of this Section.

1.03 Related Work:

A. Section 08110 - Metal Doors and Frames

B. Section 08410 - Aluminium Windows

1.04 Alternatives:

A. Refer to Section 01002 for requirements pertaining to acceptance of alternatives.

1.05 Submittals:

A. Submit samples of all products under this Section, if requested by the Engineer, prior to ordering of any item.

1.06 Codes and standards:

A. The following applicable standards established by the Bureau of Indian Standards govern the materials and workmanship for the work under this Section:

1 IS – 1081 Code of practice for fixing and glazing of metal (steel and aluminium) doors, windows and ventilation.

B. Where provisions of the pertinent codes and standards conflict with these Specifications, Drawings and Datasheets or with each other, comply with the more stringent provisions.

C. Use the latest issue of Standards.

PART 2 - PRODUCTS

2.01 General:

A. Comply with product requirements as specified and/or as indicated on the Drawings.

2.02 Materials:

A. Plate glass shall be float or plain glass conforming to the requirements of quality at least 5.50 mm thick.

B. Glazing compound, if required, shall be as approved by the Engineer.

2.03 Approved Suppliers/Manufacturers:

A. Saint Gobain

B. Asalin Glass Co.

C. Modi, Mumbai

D. Or equivalent approved.

PART 3 - EXECUTION

3.01 General:

A. Comply with the execution requirements as specified.

B. Work under this Section shall be performed by skilled labour and shall be of the highest quality.

3.02 Examination:

A. Inspection:

1. Prior to all work of this section, carefully inspect the installed work and verify that all such work is complete to the point where this installation may properly commence.

2. Verify that units may be erected in accordance with all pertinent codes and regulations, the referenced standards and the original design.

B. Discrepancies:

1. In the event of discrepancies, immediately notify the Engineer.

2. Do not proceed with installation in areas of discrepancy until all such discrepancies have been fully resolved.

3.03 Installation:

A. Verify that glazing frames are installed square and plumb.

1. Install glass on neoprene blocks set near the lower corners of frames.

2. Glazing compound shall be used as it comes from the original container and shall be applied in accordance with the manufacturers' instructions.

3. Install stops accurately. Stops shall be free from dents, scratches and other imperfections and subject to the approval of the Engineer.

END OF SECTION 08800.

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SECTION 09000 FINISHES

PART 1 -GENERAL

1.01 Reference:

A. The General Conditions, Particular Conditions, Contract Forms, Instruction to Bidder, and the requirements of Division 1 specified before, in addition to any and all Addenda, apply to and govern each Section of this Division.

B. This Section covers the general requirements for the work of this Division and shall be read in conjunction with other Sections in this Division.

C. This Section governs the work of other Sections in this Division.

1.02 Work Included:

A. The work of this Section includes, but is not necessarily limited to, the supply of labour, materials and equipment for:

1. Supply and application of cement plaster to RCC and brick work including finishing smooth with neeru.
2. Supply and application of paints and finish products, as specified for walls, ceilings, doors, rolling shutters, bollards, structural steel, valves, piping and equipment touch-up.
3. Repair or replace finished surfaces damaged during construction.
4. Finishing materials and products as hereinafter specified and as shown on the Drawings.

1.03 Co-ordination:

A. Co-ordinate with the work of other Divisions before installing work included in this Division. If work is installed without co-ordination with other works, the Engineer may direct that such work be removed, relocated and/or modified as necessary. Comply promptly with any Engineer's requests. Complete any correction and/or additional work, as directed by the Engineer.

B. For coordination requirements refer to Section 01002

1.04 Submittals:

A. Submit shop drawings, product data, documents and samples with necessary details for items in accordance with Section 01007 and As-Built drawings as per Section 01016.

1.05 Codes and Standard:

A. The following applicable standards established by the Bureau of Indian Standards govern the materials and workmanship for the work under this Division.

1. National Building Code of India-latest revision

B. Where provisions of the pertinent codes and standards conflict with these Specifications, Drawings and Datasheets or with each other, comply with the more stringent provisions.

C. Use the latest issue of Standards.

PART 2 - PRODUCTS

2.01 General:

A. Comply with product requirements outlined in the individual Sections and/or as specified on the Drawings. Select all other materials, not specifically described but

required for the proper completion of this Division, subject to the approval of the Engineer.

2.02 Fire Protection for materials and equipments:

A. All materials and equipments specified under this division shall be provided in accordance with NFPA 820 and the NEC-Area Electrical Classification details provided on the drawings.

B. Zones indicated in the drawings refers to divisions specified in NFPA 820

PART 3 -EXECUTION

3.01 General:

A. Comply with execution requirements as specified, and/or as shown on the Drawings.

3.02 Delivery, Storage and Handling:

A. Deliver, store and handle equipment, finishing materials and paints carefully to prevent damage. Do not remove materials from crates or other protective covering until ready for installation.

B. Store materials in a weather-tight building, raised clear of the ground so that the materials are protected from weather, dampness and deterioration.

C. Remove material from site for which shelf life has expired.

END OF SECTION 09000.

SECTION 09100 PLASTER

PART 1 -GENERAL

1.01 Reference:

A. Section 09000 applies to and governs the work of this Section.

1.02 Work Included:

A. Provide labour, materials and equipment necessary to do the plastering work indicated on the Drawings and as specified.

B. The drawings, data sheets and specifications are intended to set the acceptable minimum standard.

1.03 Related Work:

A. The following related work is covered elsewhere in the contract documents:

1. Division 2 - Site work
2. Division 3 - Concrete
3. Division 4 - Masonry
4. Division 8 - Doors and Windows

1.04 Alternatives:

A. Not applicable.

1.05 Submittals

A. Submit product data and samples in accordance with Section 01007 and As-Built drawings as per Section 01016.

B. Certification:

1. Submit laboratory test certificates for the materials such as cement, sand and neeru to the Engineer before delivery to site.

1.06 Codes & Standards:

A. The following applicable standards established by the Bureau of Indian Standards govern the materials and workmanship for the work under this section.

1	IS: 1542	Specification for sand face plaster
2	IS: 1661	Code of practice for application of cement and cement
3	IS 2395 Part 1:	Line finishes Painting of concrete, masonry and plaster surfaces – operations and workmanship
4	IS 2395: Part 2	Code of practice for painting concrete, masonry and plaster surfaces – Schedule
5	IS 712	Specification for building limes.

B. Where provisions of the pertinent codes and standards conflict with these Specifications and Drawings or with each other comply with the more stringent provisions.

C. Use the latest issue of Standards.

PART 2 - PRODUCTS

2.01 Materials:

A. Water

1. Water shall be free from deleterious materials, potable from the municipal main or other source approved by the Engineer.
2. Storage for the water shall be of sufficient size to ensure that there is a sufficient supply of water required for the work.

B. Sand

1. Sand shall be sharp, coarse and of approved quality and free from salt, earth, dust, silt or other impurities.
2. Sand may be washed and or/screened to meet required quality.

C. Cement

1. Cement shall be ordinary Portland cement or pozzolana cement of approved Indian manufacture and shall comply with relevant Indian standards in force. Compression and tensile tests on cement-sand cubes shall be made.
2. Cement shall be fresh when delivered. Cement shall be delivered in sound and properly secured bags, barrels or other packages ready for immediate use and shall be used directly from the bags or barrels.
3. Cement shall be stored in a watertight, well-ventilated and otherwise suitable shed or godown. The floor shall be raised not less than 450 mm from above ground level.
4. Maintain a sufficient stock of cement to ensure continuity of the work and each consignment shall be stacked separately to permit easy access for inspection and identification.
5. Cement stored for more than 90 days shall not be used.

D. Neeru

1. Neeru shall be from a reputable manufacturer as per IS 712.

E. Ready-mix plaster shall be used with the approval of Engineer.

2.02 Approved Manufacturers/ Products for Water proofing compound

A. Dr. Fixit Pidiproof LW+,
B. Sika
C. or equivalent as approved.

PART 3 - EXECUTION

3.01 General:

A. Carry out the plastering work as shown on the Drawings and as specified.

B. The joints of masonry work shall be raked out to 20mm. The surface of concrete and reinforced concrete work shall be dented in the manner specified for reinforced concrete work before plaster is applied. All the surfaces shall be thoroughly washed and well-watered before plaster is applied.

C. Joints on the external side of walls under beams shall be filled with mortar and cured properly for seven days before the commencement of plastering.

D. A long straight edge shall be used to ensure an even surface. Corners and angles shall be plumb and true and soffits of arches shall be true arcs of circles. Exposed angles with door and window frames shall be carefully finished. Internal angles shall be rounded and arises shall be rounded, splayed as appropriate.

3.02 Cement Plaster

A. The plaster on internal walls shall consist of single coat. The undercoat shall be minimum 12 mm thick and shall be of one part cement and 3 parts coarse sand and shall be dashed against the wall. It shall be uniformly applied and shall be floated and the surface shall be made even. The finishing shall be a smooth and even surface to the satisfaction of the Engineer.

B. Plaster to ceiling and other internal concrete surfaces shall be as for walls.

C. Adequate time interval shall be allowed between the applications of successive coats of plaster for hardening. The coats shall be kept moist by watering and shall not be allowed to dry out.

D. Waterproof compound shall be added for plastering to water-retaining structures.

E. In bathrooms, cement plaster shall be broom finished for tiling work.

3.03 Sand Faced Plaster

A. Sand face plaster shall be applied to external faces of building in two coats. Cement mortar shall consist of 1 part of cement to 3 parts sand. The undercoat shall be approximately 12mm thick and second coat shall be 8mm thick. The surface of the undercoat shall be scratched by wire brush to form a key for the finishing coat, before cement has set or hardened.

B. Water proofing compound of approved make shall be added in the first and second coat of cement mortar as per manufacturer’s guideline.

C. The surface of the undercoat shall be scratched for forming the key for the finishing coat before the mortar has set and hardened.

D. The finishing coat shall be 1 part of white cement, 3 parts sand to give a grained texture. The finishing coat shall be 6 mm thick, uniformly applied and surface finished with special cork sponges recommended for textured/cement plaster work. When finished the surface shall be even and shall have a grained texture.

E. Adequate time interval shall be allowed between the applications of successive coats for hardening. The coats shall be kept moist by watering for seven days.

F. Joints between masonry and concrete members to be sealed properly. Provide chicken wire mesh along the joints of masonry and concrete members to prevent separation cracks.

3.04 Cornices & Enrichment

A. All plaster cornices, string courses, beading and mouldings around door and window openings, consoles, key stones, base mouldings, inserts, moulded panels, foliated caps and enrichments etc. to the exterior and interior walls (if of greater projection than 20 mm to be laid with projecting masonry and/or concrete work) shall be rough-cast in mortar, clear cut, rubbed smooth until a high polish is obtained and finished with clean sharp arises in strict accordance with the details supplied. Lines of mouldings shall be parallel.

B. Plaster cornices shall be laid with projecting masonry and /or concrete work as the case may be. Nailed cornices shall not be allowed.

3.05 Ceiling Fibrous Plaster of Paris

A. The work shall be carried out by an approved person/agency specializing in plaster of Paris work.

B. The fibrous plaster of Paris boards shall be made from the best quality plaster of Paris reinforced with jute fibres. The board shall be 12mm thick and shall be cast on plate glass to obtain an acceptable smooth surface on one side.

C. The board shall be fixed to ceiling joists and battens with brass screws. The joints in the boards shall be flush and filled with a paste of plaster of Paris and the whole surface shall be smooth, uniform and even.

D. Cornices and other enrichments shall be provided wherever required. They shall be cast to the exact profile with clean and sharp edges, arises, moulds and shall be made of plaster of Paris reinforced with jute fibers. They shall be filled with plaster of Paris paste and on completion shall give a neat and clean appearance.

END OF SECTION 09100

SECTION 09320 CERAMIC TILES

PART 1 -GENERAL

1.01 Reference:

A. Section 09000 applies to and governs the work of this Section.

1.02 Work Included:

A. Supply and installation of ceramic-type floor tiles Grouting of floors to receive tile, to bring surfaces to the required elevation and slope.

B. The Drawings, Datasheets and Specifications are intended to set the acceptable minimum standard.

1.03 Related Work:

A. The following related work is covered elsewhere in the Contract Documents:

1.	Division 2	-	Site Work
2.	Division 3	-	Concrete
3.	Division 11	-	Equipment
4.	Division 15	-	Mechanical

1.04 Alternatives:

A. Not applicable to this Section

1.05 Submittals:

A. Submit shop drawing product data and samples of ceramic tiles in accordance with Section 01007 and As-Built drawings as per Section 01016.

B. Provide shop drawings showing tile setting pattern, location of all plumbing fixtures and locations of all expansion joints.

C. Submit duplicate 600 mm square sample panels of each colour, texture, size and pattern of the proposed tiles, mounted on 12 mm thick plywood and grout joints to represent project installation. Obtain approval of each tile sample prior to supplying material to project.

1.06 Codes and Standards:

A. The following applicable standards established by the Bureau of Indian Standards govern the materials and workmanship for the work under this section:

IS 13630 (16 Parts)	Ceramic tiles - methods of test.
IS 13712	Ceramic tiles - definitions, classifications, characteristics and making.

B. Where provisions of the pertinent codes and standards conflict with these Specifications and Drawings or with each other comply with the more stringent provisions.

C. Use the latest issue of Standards.

PART 2 - PRODUCTS

2.01 General:

A. Comply with the product requirements as specified.

2.02 Materials:

A. Providing and fixing approved sizes of ceramic flooring tiles of approved make or equivalent and of first quality to floors and dado including backing and bedding of cement mortar, cement floating and joints filled with white or coloured cement, washing and acid cleaning etc.

B. Before using the tiles, provide to the Engineer laboratory test reports as specified in IS codes.

C. Refer to Section 09900 for colour selection.

D. The sizes of ceramic flooring tiles except for washrooms shall be 450 mm x 450 mm or as approved by the Engineer.

E. All the flooring tiles in washrooms shall be anti skid with the sizes of 300 mm x 300 mm or as approved by the Engineer.

F. White or coloured glazed tiles shall be used for cladding in washrooms with sizes of 200 mm x 300 mm or as approved by the Engineer.

G. Joint grout shall be cement grout as specified or approved equivalent. Grout colour shall be selected to match tile or as selected by the Engineer from the supplier's standard range.

H. Cement : Standard Portland cement in accordance with relevant IS Code.

I. Sand : For floor setting bed – passing No 8 sieve, with not more than 5% passing No 100.

J. Lime : as per relevant IS Code.

K. Water : Potable.

2.03 Mortar Mixes:

A. Mortar bed : 1 part cement, not more than 5% hydrated lime by volume of cement, 3 parts sand, 1 part water.

B. Slurry Coat : Cement and water mixed to creamy paste.

2.04 Approved Manufacturers/Suppliers:

A. Johnson Tiles,

B. Bell Ceramic Ltd,

C. Kajaria Ceramics ltd,

D. Nitco Tiles Ltd. or equivalent as approved.

PART 3 - EXECUTION

3.01 General:

A. Comply with the execution requirements as specified.

B. The tiling work shall be done as per the pattern shown on the Drawings or as otherwise approved by the Engineer. As a general practice, laying of tiles shall be commenced from the centre of the room and advanced towards the walls. Cut tiles, if any, shall be laid along walls. Tiling work shall be completed by pressing firmly into place along the wall / floor.

3.02 Installation:

A. Ceramic Tile Flooring:

1. Ceramic tiles shall be of specified size, best quality and of approved make and colour.
2. Obtain tiles from one source only.
3. All the tiles which shall be used in the work shall strictly conform to the approved samples.
4. The surfaces where the tiles are to be laid shall be thoroughly hacked, cleaned of all mortar scales, concrete lumps, loose materials, etc. and washed to remove mud, dirt etc. from the surfaces.
5. Have the surface approved by the Engineer prior to laying of tiles in flooring.
6. The prepared surface shall be thoroughly drenched with water. The glazed tiles and all specials shall be soaked in water for a minimum period of 6 hours before use.
7. A bedding of 1:3cement mortar 30 mm or more thick for flooring shall be laid evenly to level or slopes as required.
8. The glazed tiles shall be laid on the bedding with a backing of thin cement paste. Tiles shall be truly and evenly set and pressed in position to obtain a uniform plane surface. The tiles shall be close-jointed and all joints shall be uniform and run in straight lines.
9. The entire finished surface shall be thoroughly cleaned to remove all cement stains etc.
10. The joints shall be pointed with a neat cement of matching colour after initial setting.
11. The flooring shall be kept wet for seven days.
12. The flooring shall be thoroughly cleaned with suitable hydrochloric acid before handing over.

B. Dado:

1. Joints of brick work shall be raked and cleaned properly.
2. The prepared surface shall be watered and plastered with 1:3 cement mortar to get a backing of 30mm thick. The plastered surfaces shall be even, uniform and true to plumb.
3. The glazed / ceramic tiles shall be fixed in position with a backing of cement paste.
4. The specifications for workmanship regarding joints, specials, cleanings, curing etc shall be the same as for ceramic tile flooring.
5. The surface shall be acid washed to provide a clean surface.

3.03 Precautions:

A. Protect tiled flooring from all traffic for a minimum of 36 hours. Protect at this time by using kneeling boards. General traffic not permitted for 72 hours.

B. Protect tiled and adjacent surfaces against stains or other damage. Where such damage occurs it shall be rectified without delay. Tile floors shall be left clean after grouting and protected with a suitable covering of paper before others have access. Board walkways shall be laid where continuous passage is required.

3.04 Expansion Joints:

A. Provide 6 mm wide expansion joints extending through tile surfaces and mortar setting bed to surface of structural concrete sub-floor along all walls and at intervals of 4800 mm in both directions in open floor areas. For joint back-up strips, use flexible and compressible type of close-celled polyethylene foam or butyl rubber rounded at the top to contact surface sealant. Use strips 6 mm wide and as high as required. Provide two-component sealant of 3.18 mm height at the surface, colour to match. Carefully clean all tile edges to which sealant will bond.

3.05 Extra Tiles:

A. Provide supplementary tiles in the amount of 5% of the total quantity of tiles to be installed on the job for each colour and type of tile supplied. Tiles to be boxed for storage.

3.06 Quality Assurance:

A. Tile setting shall be performed by skilled workers and work shall be performed to the highest standard of workmanship.

B. Perform tile work conforming to Installation Manual 200 – 1979 Ceramic Tile, produced by Terrazzo Tile and Marble Association of India, except where specified otherwise.

END OF SECTION 09320.

SECTION 09500 COLOUR COATED GALVALUME ROOFING

PART 1 -GENERAL

1.01 Reference:

A. Section 09000 applies to and governs the work of this Section.

1.02 Work Included:

A. The Contractor shall furnish all labour, materials, tools and services necessary to complete all work in roof sheeting, louvers, side cladding etc. in accordance with the drawings and as specified therein.

B. The Drawings, Datasheets and Specifications are intended to set the acceptable minimum standard.

1.03 Related Work:

A. The following related work is covered elsewhere in the Contract Documents:

1. Division 13 - Control and Instrumentation
2. Division 15 - Mechanical
3. Division 16 - Electrical

1.04 Alternatives:

A. Refer to Section 01002 for requirements pertaining to acceptance of alternatives.

1.05 Submittals:

A. Submit shop drawings, product data and samples of ceiling tile and suspension members in accordance with Section 01007 and As-Built drawings as per Section 01016.

B. Shop drawings shall include exact location for the start of fixing work, location of openings and all necessary detailed drawings for execution with brochures and catalogues for approval.

1.06 Codes and Standards:

A. The following applicable standards established by the Bureau of Indian Standards govern the materials and workmanship of the work under this Section.

1. IS:2527 : Code of Practice for fixing rain water gutters and down pipes for roof drainage.
2. IS:277 : Specification for galvanised steel sheets (plain and corrugated).

B. Where provisions of the pertinent codes and standards conflict with these Specifications and the Drawings or with each other comply with the more stringent provisions.

C. Use the latest issue of Standards.

PART 2 - PRODUCTS

2.01 General:

A. Comply with product requirements.

B. Select other materials not specifically described but required for proper completion of the work of this Section, subject to the approval of the Engineer.

2.02 Materials:

A. These sheets shall be manufactured by roller coating process using polyester based paints and galvalume / zinc aluminium sheets as base substrate.

B. Colour quoted roofing sheet comprising of Hi -Rib profiled manufactured out of 0.5 mm TCT (Total coated thickness) high tensile zinc aluminium alloy coated with an alloy in the ratio of 55% aluminium, 43.4% zinc & 1.5% silicon plain galvalume high tensile cold rolled steel as per AS 1397, coating class AZ 150 (min. 150gm/ m2 zinc aluminium alloy coating mass, total both side, 550 Mpa Yield strength) conforming to AS 1397. The minimum thickness of primer and polyester coating on topside shall be follows|:

1.	Epoxy primer	5 to 7 Microns
2.	Alkyd Back Coat	5 to 7 Microns
3.	Polyester Top Coat (silicon modified polyester paint, better resistance against detergents and acid fumes)	12 to 16 Micron
4.	Nominal minimum coating	22 to 30 Microns

C. Colour Coated Galvanised Sheets shall be supplied by approved vendors.

PART 3 -EXECUTION

3.01 General:

A. Comply with the execution requirements as specified and or as shown on the Drawings.

3.02 Installation:

A. The sheet shall be laid from left to right and from bottom to upwards on the slopes with rib up and with overlapping (female) facing towards starting edge to commence fixing, place the first sheet in position with the female rib in line with other building elements and fasten the sheets. Lap the female rib (with turned down free edge) of the second sheet over the male rib (with turned out bottom edge) of the first sheet and insert side lap fasteners to hold lap firmly in place before fastening second sheet to support.

B. The side laps are with special male / female side laps and anti-siphoning feature to prevent leakages. Sheets shall be fixed with self-drilling & self-tapping hot dip zinc coated Buildex / corroshield polymer coated hexed fastener of 12G-14TPIx55-58mm or required length (suitable for above item) with EPDM washer as per AS-3566 Class 3 approved screws on upto 12mm thick purlins.

C. The over hang at the ends should not exceed 250mm. The expanded polythene foam filler block of appropriate Shape to be used at joint of ridge and roofing sheet and where there is vertical sheet cladding as Wall.`

END OF SECTION 09500.

SECTION 09510 SUSPENDED FALSE CEILINGS

PART 1 -GENERAL

1.01 Reference:

A. Section 09000 applies to and governs the work of this Section.

1.02 Work Included:

A. Supply and installation of ceiling suspension system and ceiling tile .

B. The Drawings, Datasheets and Specifications are intended to set the acceptable minimum standard.

1.03 Related Work:

A. The following related work is covered elsewhere in the Contract Documents:

1. Division 13 - Control and Instrumentation
2. Division 15 - Mechanical
3. Division 16 - Electrical

1.04 Alternatives:

A. Refer to Section 01002 for requirements pertaining to acceptance of alternatives.

1.05 Submittals:

A. Submit shop drawings, product data and samples of ceiling tile and suspension members in accordance with Section 01007 and As-Built drawings as per Section 01016.

B. Shop drawings shall include exact location for the start of fixing work, location of openings and all necessary detailed drawings for execution with brochures and catalogues for approval.

1.06 Codes and Standards:

A. The applicable standards established by the Bureau of Indian Standards govern the materials and workmanship of the work under this Section.

B. Where provisions of the pertinent codes and standards conflict with these Specifications and the Drawings or with each other comply with the more stringent provisions.

C. Use the latest issue of Standards.

PART 2 - PRODUCTS

2.01 General:

A. Comply with product requirements..

B. Select other materials not specifically described but required for proper completion of the work of this Section, subject to the approval of the Engineer.

2.02 Materials:

A. The grid suspension system shall be the exposed tee type, 600 x 600 mm grid supplied by approved supplier. Exposed areas of tees shall receive a white baked-on polyester paint.

B. Ceiling panels shall be lightweight gypsum, 600mm x 600mm x 19 mm from an approved supplier and with a vinyl-latex paint finish to match the wall finish. They shall be square, fine textured and shall be Class A.

C. Acoustic ceiling panels shall be of a corrugated pattern and perforated.

D. Concealed type false ceiling also can be used for required work. The sections shall be heavy gauge and Ceiling panels of 1220mm x 2440mm shall be used for paneling and covering works.

E. Also the ceiling shall be provided with moulding and other units for better aesthetic purpose.

2.03 Approved Manufactures/Suppliers:

A. Standard manufacturer providing material specified as per standard.

PART 3 - EXECUTION

3.01 General:

A. Comply with the execution requirements

3.02 Installation:

A. The hanger grid system and panels shall be installed by an operator approved by the grid manufacturer.

B. Ceiling work to be coordinated with electrical, mechanical and HVAC works for lights, grilles, pipes, ducts etc.

C. Ensure that panels are neatly fitted around pipes, ducts etc. Splices, if necessary, shall be staggered and tightly butted. Hold-down clips shall be used where necessary and thermal movement shall be allowed for.

D. Upon completion, remove smudges and dirt and replace any damaged sections to the satisfaction of the Engineer.

END OF SECTION 09510.

SECTION 09520 GYPSUM BOARD FALSE CEILING

PART 1 - GENERAL

1.01 Reference:

A. Section 09000 applies to and governs the work of this Section.

1.02 Work Included:

A. Supply and installation of Gypsum or equivalent approved False Ceiling System for horizontal, inclined or vertical surfaces comprising of Indian gypsum or equivalent fire, termite, moisture resistant quality boards/tiles supported on all necessary G.I. suspenders of 3 mm dia. including all other accessories such as clips, hooks etc. Cutouts, supports for air diffusers, light fittings etc. wherever required shall be provided with appropriate additional framing.

B. The Drawings, Datasheets and Specifications are intended to set the acceptable minimum standard.

1.03 Related Work:

A. The following related work is covered elsewhere in the Contract Documents:

1. Division 13 - Control and Instrumentation
2. Division 15 - Mechanical
3. Division 16 - Electrical

1.04 Alternatives:

A. Refer to Section 01030 for requirements pertaining to acceptance of alternatives.

1.05 Submittals:

A. Submit shop drawings, product data and samples of panels, suspension system and other component member in accordance with Section 01007 and As-Built drawings as per Section 01016.

B. Shop drawings shall include exact location for the start of fixing work, location of openings, trimming for light fittings, grills, suspension and fixing details and all necessary detailed drawings for execution with brochures and catalogues for approval.

1.06 Codes and Standards:

A. The following applicable standards established by the Bureau of Indian Standards govern the materials and workmanship of the work under this Section:

1. IS:2095 Specification for gypsum plaster boards
2. IS:1200 Part 10 - Method of measurement of building and civil engineering works

B. Where provisions of the pertinent codes and standards conflict with these Specifications and the Drawings or with each other comply with the more stringent provisions.

C. Use the latest issue of Standards.

PART 2 - PRODUCTS

2.01 General:

A. Comply with product requirements.

B. Select other materials not specifically described but required for proper completion of the work of this Section, subject to the approval of the Engineer.

2.02 Materials:

A. Gypsum Board False Ceiling

12.5 mm. thick Gypsum Board conforming to IS-2095 fixed to suitable suspension system.

- Upon finishing, it shall be free of any visible joints.
- It shall be smooth finished.
- Panel shall not sag, wrap or shrink.
- Panel shall be air tight.
- Panel shall not shred any fibrous or dust.
- Exposed surface shall be finished with Polyurethane Paint.
- All joints between vertical wall surface and ceiling shall be sealed with coved finish.

B. Suspension System

The suspension system shall be designed in such a way that it can provide substantial and rigid support for (the movement of personal) ceiling panels and other light and grill fittings in order that the soffit of the ceiling remains permanently true and level within specified tolerance.

The system shall make allowance for the thermal movement of the ceiling material due to the temperature variations deriving from heat emitted by light fittings or other cause.

The suspension system shall be designed to withstand a differential pressure equal to 20 cm of water column (0.2 kg./cm^2).

2.03 Approved Manufactures/Suppliers:

A. Armstrong India Ltd.,

B. or equivalent as approved.

PART 3 - EXECUTION

3.01 General:

A. Comply with the execution requirements.

3.02 Installation:

A. Setting out

The Contractor shall allow for all secondary systems of suspension as may be necessary to bridge duct or other services. Before starting work ensure that light fittings system, fire barriers, sprinklers etc. are in correct positions relative to ceiling grid. Ensure that all trades use common setting out points. Ensure that the ceiling is properly related to each grid line of the building and that there is no accumulative creep over the length or width of any ceiling. The ceilings are part of a modular co-ordination system of internal elements and the ceiling joint lines will dictate locations for pre-manufactured partitions, panels, screens etc. which will be fixed later. No cutting or making up will be allowed.

Method of erection and workmanship shall be in accordance with the standard code of practice

B. Finishing

All the joints between adjacent boards and internal angle joints including joints between vertical surface and ceiling shall be filled with joint filler.

Nails and screw head indentation and minor damage shall be made good with joint filler and/or joint finished as required by the size and depth of the defect.

Joint sealer shall be applied to the whole surface of the portion of dry lining to make the system air tight.

3.03 Method of Measurement:

The mode of measurement shall be on m2 basis less the area for cut-outs. The rate shall include materials, labour, wastage, supervision, taxes and duties, transport and all other incidental charges, preparation of detailed drawings and by works, taxes, duties etc. to complete the work in all respects. No additional payment shall be made to complete the work. Rates to be all inclusive of above and also shall include all necessary taxes, duties and any other incidental expenses required to complete the entire work in scope.

3.04 Guarantee :

Minimum guarantee shall be for 24 months

3.05 Safety:

Adequate Safety Precautions and Safety measures shall be taken by the Contractor for installation of the system

END OF SECTION 09520.

SECTION 09740 KOTAH STONE

PART 1 -GENERAL

1.01 Reference:

A. Section 09000 - Finishes, applies to and governs the work of this Section.

1.02 Work Included:

A. Supply and installation of all Kota stone type floor tiles indicated on the Drawings and as specified.

B. Grouting of floors to receive tile, to bring surfaces to the required elevation and slope.

1.03 Related Work by Other Divisions:

A. The following related work is covered elsewhere in the contract documents:

1.	Site Work	-	Division 2
2.	Concrete	-	Division 3
3.	Equipment	-	Division 11
4.	Mechanical	-	Division 15
5.	Finishes	-	Division 9

1.04 Alternatives:

A. Refer to Section 01002 for requirements pertaining to acceptance of alternative materials.

1.05 Submittals:

A. Submit shop drawings, product data and samples as specified in section 09000, in accordance with Section 01007 and “AS BUILT” as per Section 01016

B. Submit shop drawings showing tile setting pattern, location of all plumbing fixtures and locations of all expansion joints.

C. Submit duplicate 600 mm square sample pieces of hand and machine cut polished light green colour kota stone to obtain approval from Engineer, prior to supplying material to project.

1.06 Codes and standards:

A. The applicable standards established by the Bureau of Indian Standards govern the materials and workmanship employed in the manufacture of all equipment.

1.	IS 3462-1986	- Flexible PVC flooring.
2.	IS 5318-1969	- Code of practice for laying flexible PVC tiles flooring
3.	IS 1121	-Method for determination of Compressive, Transverse, and shear strength of natural Building Stones
4.	National Building Code -1985	

B. Where provisions of the pertinent codes and standards conflict with these Specifications and Drawings or with each other comply with the more stringent provision

C. Use the latest issue of Standards.

PART 2 - PRODUCTS

2.01 General:

A. Comply with the product requirements as specified as indicated on the drawings.

2.02 Materials:

A. Providing and fixing Kota Stone 25mm to 40mm thick.

B. Provide all coves, curbs and other tile accessories required.

C. Joint grout shall be Johnson grout or approved equal manufacture. Grout colour shall be selected to match tile, wall finish or as selected by the Engineer from the supplier's standard range.

D. Cement: Normal Portland

E. Sand: For floor setting bed – pass No. 8 sieve, with not over 5% passing No. 100.

F. Lime: As per relevant IS code

G. Water: Potable.

2.03 Mortar Mixes:

A. Mortar bed 50mm thick: 1 part cement, 6 parts sand and water with proportionate to get dry form.

2.04 Approved Suppliers:

A. M/s. Virat Stone, Kota, Rajasthan

B. M/s. Agarwal Stone Mart, Bazar No.2 Ramganjmandi, Kota, Rajasthan

C. M/s. Kartik Overseas Incorporation, Kota, Rajasthan or Equivalent

PART 3 - EXECUTION

3.01 General:

A. Comply with the execution requirements as specified as indicated on the drawings.

B. Hand or machine cut with machine polished Kota stone 600x600 with 25 mm thick to floor as per approved pattern on bedding of cement, floated and jointed including machine polishing curing and cleaning.

C. Providing edge chamfering, polishing, grooves in treads etc as per the detailed drawings.

D. Providing and laying PVC flooring above the Kota stone flooring in Control Panel room with PVC skirting with height 150 mm.

3.02 Installation:

A. Floor:

1. Kota stone shall be installed on 50 mm thick dry mortar with leveling, cleaning, curing etc.
2. Install tiles on floor substrata in accordance with relevant IS Code except as specified otherwise.
3. Clean concrete subsurface of all dust, paint, form release agents, laitance and other foreign matter.
4. Moisten concrete subsurface and then sprinkle with dry cement. The slurry created shall be thoroughly broomed into the rough slabs.

5. Spread the bedding mortar over the concrete tamped and screed to smooth, level bed and sloped to drains. Apply bedding mortar to raise subsurface to the proper elevation, nominal slope this bedding mortar to drains as indicated on the Drawings or with a minimum slope of 1: 100.

B. PVC Flooring:

1. The surface shall be level and free from undulation and any loose material etc.
2. PVC sheet flooring shall be laid with proper cutting edge, free from bubbles and insure to apply the good quality adhesive.

3.03 Precautions:

A. Protect floor from all traffic a minimum of 36 hours. Protect at this time by using kneeling boards. General traffic not permitted for 72 hours.

B. Protect tiled and adjacent surfaces against stains or other damage. Where such damage occurs it shall be rectified without delay. Tile floors shall be left clean after grouting and protected with a suitable covering of paper. Board walkways shall be laid where continuous passage is required.

3.04 Expansion Joints:

A. Provide 6mm wide expansion joint extending through tiles surfaces and mortar setting bed to surface of structural concrete sub-floor along all walls, and at intervals for 4800 mm in both directions in open floor areas. For joint back-up strips use a flexible and compressible type of close celled polyethylene foam or butyl rubber rounded at the top to contact surface sealant. Use strips 6mm wide and high as required. Provide two-component sealant of 3.18 mm height at the surface, colour to match. Carefully clean all tile edges to which sealant will bond.

3.05 Extra Tile:

A. Provide supplementary tiles in the amount of 5% of the total quantity of tiles to be installed on the job for each colour and type of tile specified. Tile to be boxed for storage.

3.06 Quality Assurance:

A. Tile setting shall be performed by skilled worker and all work shall be performed to the highest standard or workmanship.

B. Do work confirming to Installation Manual 200 – 1979 “Ceramic Tile”, produced by Terrazzo Tile and Marble Association of India, except where specified elsewhere.

END OF SECTION 09740.

SECTION 09741 GRANITE STONE

PART 1 -GENERAL

1.01 Reference:

A. Section 09000 - Finishes, applies to and governs the work of this Section.

1.02 Work Included:

A. Supply and installation of all Granite stone type floor tiles indicated on the Drawings and as specified.

B. Grouting of floors to receive tile, to bring surfaces to the required elevation and slope.

1.03 Related Work by Other Divisions:

A. The following related work is covered elsewhere in the contract documents:

1.	Site Work	-	Division 2
2.	Concrete	-	Division 3
3.	Equipment	-	Division 11
4.	Mechanical	-	Division 15
5.	Finishes	-	Division 9

1.04 Alternatives:

A. Refer to Section 01002 for requirements pertaining to acceptance of alternative materials.

1.05 Submittals:

A. Submit shop drawings, product data and samples as specified in section 09000, in accordance with Section 01007 and “AS BUILT” as per Section 01016

B. Submit shop drawings showing tile setting pattern, location of all plumbing fixtures and locations of all expansion joints.

C. Submit duplicate 600 mm square sample pieces of hand and machine cut polished granite stone to obtain approval from Engineer, prior to supplying material to project.

1.06 Codes and standards:

A. The applicable standards established by the Bureau of Indian Standards govern the materials and workmanship employed in the manufacture of all equipment.

1. National Building Code -1985
2. IS 1121 -Method for determination of Compressive, Transverse, and shear strength of natural Building Stones
3. IS 3316 - Specification for Structural Granite

B. Where provisions of the pertinent codes and standards conflict with these Specifications and Drawings or with each other comply with the more stringent provision

C. Use the latest issue of Standards.

PART 2 - PRODUCTS

2.01 General:

A. Comply with the product requirements as specified as indicated on the drawings.

2.02 Materials:

A. Providing and fixing Granite Stone of approved thickness and colour.

B. Provide all coves, curbs and other tile accessories required.

C. Joint grout shall be Johnson grout or approved equal manufacture. Grout colour shall be selected to match tile, wall finish or as selected by the Engineer from the supplier's standard range.

D. Cement: Normal Portland

E. Sand: For floor setting bed – pass No. 8 sieve, with not over 5% passing No. 100.

F. Lime: As per relevant IS code

G. Water: Potable.

2.03 Mortar Mixes:

A. Mortar bed 50mm thick: 1 part cement, 6 parts sand and water with proportionate to get dry form.

2.04 Approved Suppliers:

A. M/s. Virat Stone, Kota, Rajasthan

B. M/s. Agarwal Stone Mart, Bazar No.2 Ramganjmandi, Kota, Rajasthan

C. M/s. Kartik Overseas Incorporation, Kota, Rajasthan or as equivalent.

PART 3 - EXECUTION

3.01 General:

A. Comply with the execution requirements as specified as indicated on the drawings.

B. The slabs shall be of approved selected quality, hard, sound, dense and homogenous in texture, free from cracks, decay, weathering and flaws. The percentage of water absorption shall not exceed 5 percent as per test conducted in accordance with IS : 1124.

C. The slabs shall be hand or machine cut to the required thickness. Tolerance in thickness for dimensions of tile more than 100mm shall be ±5mm. This shall be ±2mm on dimensions less than 100mm.

D. Slabs shall be supplied to the specified size with machine cut edges or fine chisel dressed to the full depth. All angles and edges of the slabs shall be true and square, free from any chipping giving a plane surface. Slabs shall have the top surface machine polished (first grinding) before being brought to site. The slabs shall be washed clean before laying.

E. Providing edge chamfering, polishing, grooves in treads etc as per the detailed drawings.

3.02 Installation:

A. Floor:

1. Granite stone shall be installed on 50 mm thick dry mortar with leveling, cleaning, curing etc.
2. Install tiles on floor substrata in accordance with relevant IS Code except as specified otherwise.
3. Clean concrete subsurface of all dust, paint, form release agents, laitance and other foreign matter.

4. Moisten concrete subsurface and then sprinkle with dry cement. The slurry created shall be thoroughly broomed into the rough slabs.
5. Spread the bedding mortar over the concrete tamped and screed to smooth, level bed and sloped to drains. Apply bedding mortar to raise subsurface to the proper elevation, nominal slope this bedding mortar to drains as indicated on the Drawings or with a minimum slope of 1: 100.

3.03 Precautions:

A. Protect floor from all traffic a minimum of 36 hours. Protect at this time by using kneeling boards. General traffic not permitted for 72 hours.

B. Protect tiled and adjacent surfaces against stains or other damage. Where such damage occurs it shall be rectified without delay. Tile floors shall be left clean after grouting and protected with a suitable covering of paper. Board walkways shall be laid where continuous passage is required.

3.04 Expansion Joints:

A. Provide 6mm wide expansion joint extending through tiles surfaces and mortar setting bed to surface of structural concrete sub-floor along all walls, and at intervals for 4800 mm in both directions in open floor areas. For joint back-up strips use a flexible and compressible type of close celled polyethylene foam or butyl rubber rounded at the top to contact surface sealant. Use strips 6mm wide and high as required. Provide two-component sealant of 3.18 mm height at the surface, colour to match. Carefully clean all tile edges to which sealant will bond.

3.05 Extra Tile:

A. Provide supplementary tiles in the amount of 5% of the total quantity of tiles to be installed on the job for each colour and type of tile specified. Tile to be boxed for storage.

3.06 Quality Assurance:

A. Tile setting shall be performed by skilled worker and all work shall be performed to the highest standard or workmanship.

B. Do work confirming to Installation Manual 200 – 1979 “Ceramic Tile”, produced by Terrazzo Tile and Marble Association of India, except where specified elsewhere.

END OF SECTION 09741.

SECTION 09790 EPOXY FLOOR TREATMENT

PART 1 -GENERAL

1.01 Reference:

A. Section 09000 applies to and governs the work of this Section

1.02 Work Included:

A. Supply and application of the non-metallic, dry shake floor hardener, premixed powder containing selective hard aggregates having hardness 9 on Moh's scale, as per ASTM C501, H22 wheel on all exposed concrete floors unless otherwise specified and as shown on the Drawings.

B. The product shall enhance surface abrasion resistance and shall not exceed wear of 0.25 mg/cycle when tested to ASTM C501, H22 wheel.

C. The Drawings, Datasheets and Specifications are intended to set the acceptable minimum standard.

1.03 Related Work:

A. The following related work is covered elsewhere in the Contract Documents:

1.	Division 3	-	Concrete
2.	Division 4	-	Masonry

1.04 Alternatives:

A. Refer to Section 01002 for requirements pertaining to acceptance of alternatives.

1.05 Submittals:

A. Submit shop drawings, product data and samples as specified in section 09000, in accordance with Section 01007 and As-Built drawings as per Section 01016.

B. Shop drawings shall include exact location for the start of the work, location of openings and all necessary detailed drawings for execution with brochures and catalogues for approval.

1.06 Codes and Standards:

A. The following applicable standards established by the Bureau of Indian Standard govern the materials and workmanship for the work under this section.

1	IS 9197	Specification for epoxy resin, hardeners and epoxy resin compositions for floor topping
2	ASTM – C -501	Abrasion Resistance, H22 wheel, floor hardeners

B. Where provisions of the pertinent codes and standards conflict with these Specifications, Drawings and Datasheets or with each other, comply with the more stringent provisions.

C. Use the latest issue of Standards

PART 2 - PRODUCTS

2.01 General:

A. Comply with product requirements as specified and/or as shown on the Drawings.

2.02 Materials:

A. Non-slip additive is required and shall be clean, dry, No 25 mesh silica sand.

B. Chemical resistant floors shall have a two-component epoxy primer and modified polymer floor coating. Refer to Section 09900 for colour selection.

2.03 Approved Manufacturers/ Suppliers

A. BASF India

B. or equivalent as approved.

PART 3 - EXECUTION

3.01 General:

A. Comply with the execution requirements as specified and/or as shown on the Drawings.

B. Comply with the application instructions provided by the manufacturer.

3.02 Examination:

A. Inspection:

1. Before starting work under this Section, carefully inspect the installed work and verify that all such work is complete to the point where this installation may properly commence.

B. Discrepancies:

1. In the event of discrepancies, notify the Engineer immediately.

2. Do not proceed with installation in areas of discrepancy until all such discrepancies have been fully resolved.

3.03 Surface Preparation:

A. The concrete shall have cured for at least 28 days before installation begins.

B. New concrete shall be finished with a fine broom or wooden float. Care shall be taken not to raise any unnecessary laitance to the surface. Concrete shall be properly cured without the use of chemical curing agents. Any methods or materials that would prevent the proper bonding of an epoxy material shall not be used.

C. Any hard trowelled or contaminated concrete areas shall be abrasive cleaned as necessary to ensure that the concrete is free of all paint, sealers, curing agents, paint, oil, grease, moisture, dirt and other contaminants.

D. Placing: The epoxy floor finish shall be applied strictly in accordance with the manufacturer's instructions.

E. Coverage:

1. The rate of application of the epoxy compound depends on the service conditions, which the floor will be exposed to. The rates of application are as below:

a. For heavy-duty traffic : 6-8 kg/m^2
b. For medium duty traffic : 5-6 kg/m^2

c. For light duty traffic : 3-5 kg/m^2

3.04 Quality Assurance:

A. Floor treatment shall be applied on exposed concrete floor surfaces, unless otherwise specified, by skilled applicators with previous experience with the materials specified.

3.05 Precautions:

A. During hot, dry or windy conditions trowelling shall be kept to the minimum to obtain the required finish.

B. All moisture used to incorporate dry-shake material must come from within the slab. Under no circumstances shall water be applied to aid in the incorporation of dry shake.

END OF SECTION 09790.

SECTION 09791 EPOXY LINING

PART 1 -GENERAL

1.01 Reference:

A. Section 09000 applies to and governs the work of this Section.

1.02 Work Included:

A. Supply and application of the epoxy lining to wet well walls & floors as specified herein and as shown on the Drawings.

B. For schedule refer to Section 09900.

C. The Drawings, Datasheets and Specifications are intended to set the acceptable minimum standard.

1.03 Related Work:

A. The following related work is covered elsewhere in the contract documents:

1.	Division 3	-	Concrete
2.	Division 4	-	Masonry

1.04 Alternatives:

A. Refer to Section 01002 for requirements pertaining to acceptance of alternatives.

1.05 Submittals:

A. Submit shop drawings, product data and samples as specified in Section 09000, in accordance with Section 01007 and As-Built drawings as per Section 01016.

B. Shop drawings shall include marking of start up, location of openings and all necessary detailed drawings for execution with brochures/catalogues for the approval of the Engineer.

1.06 Codes and Standards:

A. The applicable standards established by the Bureau of Indian Standards govern the materials and workmanship of the work under this Section.

B. Where provisions of the pertinent codes and standards conflict with these Specifications and Drawings or with each other, comply with the more stringent provisions.

C. Use the latest issue of Standards.

PART 2 - PRODUCTS

2.01 General:

A. Comply with product requirements as specified and or as shown on the Drawings.

2.02 Materials:

A. Floor coating shall be a two component, solvent free, self-priming epoxy floor coating, as manufactured by approved manufacturer or equivalent. See Section 09900 for colour selection.

B. Chemical resistant floor and wall coating, lining in the wet well area shall be a two component epoxy primer and modified novolac vinyl ester polymer floor coating, as approved by the Engineer. See Section 09900 for colour selection.

C. Non-slip additive is required and shall be clean, dry No. 25 mesh silica sand.

PART 3 -EXECUTION

3.01 General:

A. Comply with the execution requirements as specified.

3.02 Examination:

A. Inspection:

1. Before starting work under this Section, carefully inspect the installed work of all other trades and verify that all such work is complete to the point where this installation may properly commence.

B. Discrepancies:

1. In the event of discrepancies, notify the Engineer immediately.
2. Do not proceed with installation in areas of discrepancy until all such discrepancies have been fully resolved.

3.03 Application:

A. Thoroughly mix components and allow for a 15-20 minute induction period immediately before application. Mix only enough for immediate use.

B. Apply material surface application using rollers in accordance with manufacturer's recommendations. Finished coating shall be minimum 2 mm thick.

3.04 Quality Assurance:

A. Floor treatment shall be applied on all exposed interior concrete floor surfaces, where shown on the Drawings, by skilled applicators with previous experience with the materials specified.

3.05 Testing and Inspection:

A. The contractor shall conduct thickness measurements and inspection of the coated surfaces with equipment supplied by him and acceptable to the Employer's Representative and shall recoat and repair as necessary for compliance with these specifications.

B. Any surfaces or parts thereof found to be unsatisfactory shall be rectified by the contractor to the satisfaction of the Employer's Representative.

END OF SECTION 09791.

SECTION 09800 ACID ALKALI RESISTANT TILES

PART 1 -GENERAL

1.01 Reference:

A. Section 09000 applies to and governs the work of this Section.

1.02 Work Included:

A. Supply and installation of all acid/ alkali resistant floor and wall tiles as specified herein and as shown on the Drawings.

B. Grouting of floors to receive tile, to bring surfaces to the required elevation and slope.

C. The Drawings, Datasheets and Specifications are intended to set the acceptable minimum standard.

1.03 Related Work:

A. The following related work is covered elsewhere in the Contract Documents.

1. Division 2 - Site Work
2. Division 3 - Concrete
3. Division 4 - Masonry

1.04 Alternatives:

A. Not applicable for this Section.

1.05 Submittals:

A. Submit drawings and product data with all necessary details for execution, as specified in Section 09000 in accordance with Section 01007 and As-Built drawings as per Section – 01016.

B. Shop drawings showing tile setting pattern, location of all plumbing fixtures and locations of all expansion joints.

C. Submit duplicate sample tiles of each colour, texture, required size and pattern, mounted on 12 mm thick plywood and grout joints to represent project installation. Obtain approval of each tile sample prior to supplying material to project.

1.06 Codes and Standards:

A. The applicable standards established by the Bureau of Indian Standards govern the materials and workmanship of the work under this Section.

B. Where provisions of the pertinent codes and standards conflict with these Specifications and Drawings or with each other comply with the more stringent provisions.

C. Use the latest issue of Standards.

PART 2 - PRODUCTS

2.01 General:

A. Comply with product requirements as specified and as shown on the Drawings.

2.02 Materials:

A. Providing and fixing approved sizes of acid alkali resistant tiles of Johnson or equivalent first quality to floors and dado including backing and bedding of silicon based cement mortar and joints filled with approved chemical, washing with acid cleaning etc. See Section 09900 for colour selection.

B. The sizes of flooring tiles shall be 300 mm x 300 mm or as approved by the Engineer.

C. The size of dado tiles shall be 200 mm x 300 mm or as approved by the Engineer.

D. Provide all coves, curbs and other tile accessories as required.

E. Joint grout shall be coloured epoxy grouts to fill up the joints. Grout colour shall be selected to match tile or as approved by the Engineer from the supplier's standard range.

F. Cement: Ordinary Portland

G. Sand: For floor setting bed – pass No. 8 sieve, with not more than 5% passing No. 100 Sieve.

H. Lime:

I. Water: Potable.

2.03 Mortar Mixes:

A. Silicon based cement slurry with 5% sodium silicate liquid and polymer or as per the manufacturer's instructions.

2.04 Approved Suppliers/Manufacturers:

A. Johnson Tiles

B. or equivalent as approved.

PART 3 - EXECUTION

3.01 General:

A. Comply with the execution requirements as specified and or as shown on the Drawings.

3.02 Installation:

A. Floor Tiles:

1. Install tiles on floor substrate in accordance with relevant IS Code unless specified otherwise.
2. Clean concrete subsurface of all dust, paint, form release agents, laitance and other foreign matter.
3. Moisten concrete subsurface and then sprinkle with dry cement. The slurry created shall be thoroughly brushed into the rough slabs.
4. Spread the bedding mortar over the concrete, tamp and screed to smooth, level bed and slope to drains.
5. Apply bedding mortar to raise subsurface to the proper elevation, slope this bedding mortar to drains with a minimum slope of 1: 100.

B. Wall Tile:

1. Install tiles on walls in accordance with the respective IS Code /Installation Manual 200 – 1979 “Ceramic Tile”, produced by Terrazzo Tile and Marble Association of India, except where otherwise specified.
2. Surface to receive wall mix shall be plumb, straight and true.

C. Application:

1. Apply a thin pressured-on skim coat of setting bed grout to substrate in the area to be tiled. Do not spread more mortar than can be covered before skinning occurs.
2. Follow skim coat immediately with a doubling coat to form a mortar layer approximately 6.0 mm thick. Do not notch this layer until just before placing tile.
3. Prior to setting tile, notch the thin-set with a suitably notched trowel, combing an area that can be covered in 5 minutes in hot dry surroundings.
4. Place individual tile against freshly combed mortar with moderately firm pressure, followed by a thorough beat-in. The beat-in should be sufficient to cause mortar bed to flow into continuous layer. Make any necessary adjustment in alignment promptly following beat-in.
5. Tiles shall be bedded to required lines by straight edges with joints 6.00 mm wide.
6. Clean out joints where required of any mortar smudges with clean water.
7. Grouting shall be performed after initial set has occurred, using the specified joint grout or approved equal. Mix and apply grout in accordance with the manufacturers’ recommendations.
8. Seal grouted joints with sealer, applied in accordance with manufacturers’ instructions.

9. Cove tile base and coving of all equipment bases shall match the floor tile, colour and pattern. Tiles shall be extended over fitments and accessories, except under floor fastened and full-skirted equipment.

3.03 Precautions:

A. Protect tiled floor from all traffic for a minimum of 36 hours. During this time protect using kneeling boards as necessary. General traffic not permitted for 72 hours.

B. Protect tiled and adjacent surfaces against stains or other damage. Where such damage occurs it shall be rectified without delay. Tile floors shall be left clean after grouting and protected with a suitable covering of paper before other trades have access. Board walkways shall be laid where continuous passage is required.

3.04 Expansion Joints:

A. Provide 6 mm wide expansion joints extending through tile surfaces and mortar setting bed to surface of structural concrete sub-floor along all walls and at intervals of 4800 mm in both directions in open floor areas. For joint back-up strips use a flexible and compressible type of close-celled polyethylene foam or butyl rubber rounded at the top to contact surface sealant. Use strips 6 mm wide and high as required. Provide two-component sealant of 3.18 mm height at the surface, colour to match. Carefully clean all tile edges to which sealant will bond.

3.05 Extra Tile:

A. Provide supplementary tiles in the amount of 5% of the total quantity of tiles to be installed on the job for each colour and type of tile specified. Tile to be boxed for storage.

3.06 Quality Assurance:

A. Tile setting shall be performed by skilled tradesmen to the highest standard of workmanship.

B. Do tile work to Installation Manual 200 – 1979 “Ceramic Tile”, produced by Terrazzo Tile and Marble Association of India, except where specified elsewhere.

END OF SECTION 09800.

SECTION 09900 PAINTING

PART 1 -GENERAL

1.01 Reference:

A. Section 09000 applies to and governs the work of this Section.

1.02 Work Included:

A. The work of this Section includes painting of exterior and interior structure and site element surfaces, materials, equipment, machinery, piping, and ducting including but not limited to:

1. Concrete & masonry surfaces
2. Poured or precast concrete surfaces.
3. Ferrous metals.
4. Non ferrous metal.
5. Galvanized metal including ducts and pipes.
6. Piping and duct work.
7. Machinery and equipment,
8. Shop and field application of primers and finish coat.
9. Touch-up work on pre-finished machinery, equipment and appurtenances.
10. Interconnecting piping, rising main, bypass, hydrants and fittings etc
11. Conduits and fittings.
12. Metal flashings:
13. Buried, built into, fixed to and/or adjoining dissimilar materials.
14. All internal and external surfaces

B. Paint all piping and appurtenances except stainless steel, plastic and chrome-plated piping in accordance with these Specifications.

C. Provide piping identification by legend and arrows, as described in these Specifications.

D. Touch-up and repaint all painted surfaces damaged during construction and operation and maintenance period.

E. Unless otherwise specified, do not apply paint or protective coating to the following:

1. Copper, stainless steel, chrome plate, plastic, aluminum, bronze or brass surfaces.
2. Finishing hardware;
    a) Equipment nameplates and other such identification;
    b) Switches and other electrical device faceplates except if constructed of prime coat painted or galvanized steel, in which case they are to be painted;
    c) Lighting fixtures;
    d) Surfaces factory coated, including epoxy or enamel finishes, unless specified otherwise;

e) Plastic laminate surfaces;

f) Glass;

g) Tile products, glazed or unglazed, including quarry tile;

h) Manhole and catchbasin covers;

i) Covers or strainers associated with floor drains, cleanout terminations and similar equipment;

j) Recessed electrical boxes and similar recessed equipment;

k) Control panels/unless specified otherwise - see Coating Schedule this section.

l) Circuit breakers, switches and similar electrical devices, unless specified otherwise;

m) Galvanized or plastic coated wire fencing; posts and accessories;

n) Pre-finished metal and flashings - trim;

o) Pre-finished louvres.

p) Hardware

1.03 Related Work by Other Divisions:

A. The following related work is covered elsewhere in the Contract Documents:

1.	Site Work	-	Division 2
2.	Masonry	-	Division 4
3.	Metals	-	Division 5
4.	Doors and Windows	-	Division 8
5.	Specials	-	Division 10
6.	Equipment	-	Division 11
7.	Mechanical	-	Division 15
8.	Electrical	-	Division 16

1.04 Alternatives:

A. Refer to Section 01002 for requirements pertaining to acceptance of alternative equipment.

1.05 Submittals:

A. Submit shop drawings, product data and samples in accordance with Section 01007 and As-Built drawings as per Section – 01016.

B. Submit for review complete list of materials listing proposed manufacturer, material designation and relevant identification data prior to ordering.

C. Submit standard colour chips of all types of paint to be used. The Engineer will approve all colours for use on this project

D. Supply only approved material.

1.06 Codes and Standards

A. The following applicable standards established by the Bureau of Indian Standards govern the materials and workmanship of the work of this Section.

1. IS 5410 - External painting
2. IS 6278 - White wash and colour wash.

B. Where provisions of the pertinent codes and standards conflict with these Specifications and Drawings or with each other comply with the more stringent provisions.

C. Use the latest issue of Standards:

PART 2 - PRODUCTS

2.01 General:

A. Coatings manufactured by Asian Paints Industries are listed in the schedules in these Specifications. Equivalent products supplied by Asian Paints, Nerolac, Berger paints or equivalent companies are considered as approved alternates. The Engineer will determine the specific equivalence of any proposed alternate product.

B. Provide pure painting materials of the highest quality.

C. All painting materials and the minimum number of coats or applications of each type of material are specified in the schedules or referenced in other Sections.

D. The schedules in this Section are intended to be all-inclusive. Supply all necessary substitute or additional materials. Substitutions or additions are subject to the approval of the Engineer.

E. Provide thinners and cleaners for proper surface preparation recommended by the paint manufacturer for that particular finish paint.

F. Non-standard colours may be approved by the Engineer. Provide non-standard colours at no additional cost to the BMC.

G. Unless otherwise noted, paint or protective coatings are to be ready-mixed. Where site mixing is required for certain products, mix in strict accordance with the manufacturer's recommendations to produce smooth flowing materials with an ease of application consistency.

H. Use internal paint coatings, finishes, polishes and adhesives and sealants, which have low or zero VOC(Volatile Organic Compounds).

2.02 Paint Systems:

A. Exterior and Interior Surfaces: Coating systems/materials and colours as specified in the schedules in this Section.

2.03 Pipe and Duct Identification Markers:

A. Provide markers having legend wording and arrows printed on pressure-sensitive PVC tape, type Perma-Seal (10 mil PVC pipe/duct sleeve) manufactured by Asian Paints or approved equal.

B. Pipe/duct contents description lettering size, material flow direction arrows and colours; conform to current Standard for pipe identification in water and wastewater treatment plants,

C. Colour Code:

1. See the schedules this Section.

PART 3 - EXECUTION

3.01 General:

A. Carry out the work as shown on the Drawings and as specified.

3.02 Examination:

A. Examine surfaces to be finished before commencing work and advise the Engineer of any defective surfaces.

B. Correct defective surfaces before commencing work. Commencement of work implies the acceptance of the existing conditions.

3.03 Preparation:

A. Prior to beginning the coating work, clean all surfaces free of rust, corrosion, dirt, dust, grease or any extraneous matter.

B. Vacuum clean areas immediately prior to commencing finishing work.

C. Do not apply finishes on damp, wet or dirty surfaces.

D. Be responsible for taking all precautions or protective measures that may be necessary to suit the prevailing environmental conditions (excessive heat, humidity, spray, etc) as they may affect the work of this Section. Failure to comply with the foregoing will not be grounds for extra cost claims and will not void the specified maintenance guarantee.

E. Deliver all paint materials to the site in unopened, clearly labelled original containers.

F. Acid etch smooth concrete surfaces to achieve better paint or protective coating adhesion. Comply with paint manufacturer recommendations.

G. Prepare metal surfaces in accordance with surface preparation specification by The Steel Structures Painting Council SSPC Manual - "Systems and Specifications" and as indicated in the schedules provided in this Section.

H. Prepare galvanized metal surfaces in accordance with latest IS Code standard.

I. Abrasive blast clean shop and field welds in accordance with IS Code surface preparation indicated in the coating system provided at the end of this Section.

J. Test all surfaces for moisture content with an electronic moisture meter and test concrete, masonry and gypsum surfaces for acid-alkali balance.

K. Maintain at the site at all times until the work is completed, a moisture meter, hygrometer and thermometer to verify surface and environmental conditions.

L. Finish glazing rebates before glazing work commences.

M. Apply finishing materials at proper consistency, free from brush marks, sags, crawls, streaks, runs, laps, skips, voids, pinholes, missed areas and other perceptible defects, and with even colour, sheen, and texture.

N. Apply finishing and coating materials to provide full coverage and at a rate to provide the dry film thicknesses specified, but not to exceed that recommended by the manufacturer for the applicable surface.

O. Make clean, true junctions with no overlap between adjoining applications of finish coatings.

P. Leave all parts of mouldings and ornaments clean and true to details with no undue amount of coating in corners and depressions.

Q. Use materials of a single manufacturer in coating system.

R. Apply each coat only after the preceding coat is dry and hard, or as otherwise directed by the material manufacturer.

S. Sand surfaces lightly with appropriate sandpaper between coats on wood and metal.

T. Prior to the application of special finishes and coatings, arrange for a meeting at the site with the Engineer, the painting sub-contractor and a representative of the special finish(es) manufacturer(s) to discuss the condition of surfaces to receive special finish, and application procedures.

U. Scrub and treat mildewed surfaces with a solution of trisodium phosphate bleach with a solution of one part sodium hydrochloride (Javex) to three parts water and rinse with clear water.

V. Arrange for the removal of finishing hardware, electrical plates, accessories and similar removable fittings on surfaces to be finished. Mask any other work that is not removable.

W. Prepare surfaces to be painted or coated such that the surfaces are thoroughly dry and free of chemicals, mortar splatters, organic matter, oil, grease, rust, scale, loose paint, and any other material and such that the surfaces are in a proper condition to receive paint, stain or other specified coating.

3.04 Application:

A. Apply all material and protective coating finish in strict accordance with latest IS Code and the manufacturer's recommendations and as specified herein. In the event of any conflict in specifications, the more stringent specifications apply.

B. Do not field blend colours unless approved by the Engineer.

3.05 Protection during Sandblasting:

A. Comply with current Environmental Protection Act: Refer to Section 01011.

1. Provide complete vacuum recovery system during any sandblasting operations.

B. Provide a shroud during sandblasting operations. The shroud to be designed so that contaminants do not leave the site during sandblasting. Alternative protection measures will be permitted provided that they meet the requirements of the Ministry of the Environment & Forest. It will be the responsibility of the Contractor to Obtain MOEF approval of the alternative measures.

3.06 Protection:

A. Cover or mask surfaces adjacent to those receiving treatment and finishing to protect the work of others from damage. Mask instruction and specification plates and controls attached to equipment being painted.

B. Take particular care in storage and mixing areas to ensure that floors are protected.

C. Co-ordinate with the appropriate trades for the removal from finished surfaces, storage and reinstallation after finishing work is completed, switch and receptacle plates, escutcheons, luminaire frames and similar items.

D. Post No Smoking signs and ensure that spark-proof electrical equipment is used in areas where flammable painting materials are being applied or stored.

E. Post Wet Paint signs throughout freshly finished areas to be removed when finishes are dry.

F. Provide portable ULC 10: BC rated, 8 kg carbon dioxide fire extinguisher in work areas and where paint is stored.

3.07 Touch-up Surfaces:

A. Clean areas that are to receive touch-up paint as specified.

B. Sand lightly to clean areas for spot painting and apply two finish coats to match original coating specification.

C. Provide touch-up paint of all types and colours used on this work, suitably identified, for future use by the plant operating personnel.

D. Provide at least 1.5 litres of each type and colour of paint and stain.

3.08 Pipe and Duct Identification Markers:

A. Identify exposed piping and ductwork in accordance with latest IS Code and the conditions as follows:

1. at each end of piping or duct runs;
2. at each piece of connecting equipment;
3. on both sides of every pipe and duct passing through a floor, wall or partition, unless otherwise specified;
4. at 6 m intervals on pipe and duct runs exceeding 6 m in length;
5. on each side of special valves, special fittings and branch connections;
6. at least once in each room, and at least once on pipe and duct runs less than 6 m in length.

B. Apply arrows and markers in a uniform manner truly parallel to piping and ducting.

3.09 Clean-up:

A. Upon completion, remove all materials and debris from the buildings.

B. Carefully clean all work and remove paint from all adjoining surfaces, glass, hardware, etc. The whole shall be left in a condition satisfactory to the Engineer.

3.10 Paint/Protective Coating Schedule:

DIV.	MATERIAL/ SERVICE AREA	SURFACE PREP.**	PRIME**	NO. OF COATS	FINISH**	NO. OF COATS*	COLOUR ***	REMARKS
3	Building Above Grade Dry Structure - ceilings	Dry & clean See Part 03300	PPG 6-3 Speedhide Alkali Resistant	1 (1.5 mils)	PPG 54 LIne Alkyd Enamel Flat	2 (2.0 mils each)	White	
3/4	Building Above Grade Dry Structure Masonry/ Concrete: - Interior Walls	Clean & dry See Part 03300/ 04200	PPG 16-90 Pittglaze Block Filler. See also section 09800	3	See section 09800		TBC	Waterproof-ing - See Section 07121

DIV.	MATERIAL/ SERVICE AREA	SURFACE PREP.**	PRIME**	NO. OF COATS	FINISH**	NO. OF COATS*	COLOUR ***	REMARKS
5	Galvanized Steel: (Non-immersion)	SP-1	PPG 6-209 Galv. Primer	1 (2.0 mils)	PPG 54 Line Alkyd Enamel Gloss	2 (2.0 mils each)	TBC	
5	Exposed structural, miscellaneous and cast iron steel	SP-2	PPG 97-682 Multiprime	1 (2.0 mils)	PPG 54 Line Alkyd Enamel Gloss	2 (2.0 mils each)	TBC	
5	Exposed unfinished misc. metal trim	SP-2	PPG 97-682 Multiprime	1 (2.0 mils)	PPG 54 Line Alkyd Enamel Gloss	2 (2.0 mils each)	TBC	
5	Ductile Iron: Exposed	SP-3 (SP-6 Rust)	PPG 97-682 Multiprime	1 (2.0 mils)	PPG 54 Line Alkyd Enamel Gloss	2 (2.5 mils each)	TBC	
5	Ductile Iron (Bitumen -Tar Coated)	SP-3	17-21 "Sealgrip" Latex	1 (2.0 mils)	PPG 54 Line Alkyd Enamel Gloss	2 (2.5 mils each)	TBC	
5	Galvanized Steel: (Immersion) Non-Potable Water	SP-5 SP-1 4:1 Trisodium Phosphate	PPG 97-46/98 Epoxy Primer	1 (3.0 mils)	PPG 97-130/139 Hi-build Epoxy	2 (5.0 mils each)	TBC	
5/ 11	Steel/Cast Iron/Ductile Iron "In-ground"	SP-2/3		2	PPG 97-640/641 Coal Tar Epoxy	2 (7.0 mils each)	TBC	
6	Wood/Plywood	See 009900 Part 3	PPG Speedhide 606 Enamel Undercoater	1 (1.5 mils)	PPG 54 Line Alkyd Enamel Gloss	2 (2.0 mils each)		other than stained or oiled
8	Hollow metal doors/ steel frames	SP-2	97-682 Multiprime	1 (1.5-2 mils)	PPG 54 Line Speedhide Enamel	2	TBC	
10	Alum, Louvre (shop primed)	SP-2	See Div. 10210		See Div. 10210		TBC	See Div. 10
10	Steel Louvres (shop primed)	SP-2	PPG 97-682 Multiprime	1 (2.0 mils)	PPG 54 Line Speedhide Enamel	2 (2.0 mils each)	TBC	
11	Exposed gate stands, supports	SP-2	PPG 97-682 Multiprime	1 (2.0 mils)	PPG 97-51/98 Aquapon	2 (2-3 mils each)	TBC	
11	Steel operators, gear boxes, motors, and appurtenances	SP-2	PPG 97-682 Multiprime	1 (2.0 mils)	PPG 97-51/98 Aquapon	2 (2-3 mils each)	TBC	
11	Shop primed and/or factory finished equipment (including preselected items)	SP-2	PPG 97-682 Multiprime	1 (2.0 mils)	PPG 97-51/98 Aquapon	2 (2-3 mils each)	TBC	
11/ 15/	Steel drains, vents, pipe duct	SP-2	PPG 97-682	1	PPG 97-51/98	2 (2-3 mils	TBC	

DIV.	MATERIAL/ SERVICE AREA	SURFACE PREP.**	PRIME**	NO. OF COATS	FINISH**	NO. OF COATS*	COLOUR ***	REMARKS
16	supports, cable trays, conduits, process piping		Multiprime	(2.0 mils)	Aquapon	each)		
15	Exposed surfaces of fans and shutters	SP-2	PPG 97-682 Multiprime	1 (2.0 mils)	PPG 97-51/98 Aquapon	2 (2-3 mils each)	match colour of adjacent wall and/or ceiling	
15	Fabric jacketed (steel/cast iron galvanized) surfaces including appurtenances	clean	PPG 6-2 Speedhide Sealer	1 (2.0 mils)	PPG 6-510 Speedhide S/G Enamel	2 (2-3 mils each)	TBC	
15	Fabric Jacket/Insulation on Pipes and Ducts	clean	PPG Speedhide 6-6 Enamel Undercoater	1 (1.5 mils)	PPG 54 Line Alkyd Enamel Gloss	2 (2.0 mils each)	TBC	
15 16	Mech. Machinery & Equip. Convectors, Heating Unit Enclosure	SP-2	PPG 97-682/684 Multiprime	1 (2.0 mils)	PPG 54 Line Alkyd Enamel Gloss	2 (2.0 mils each)	TBC	
16	Steel electrical conduit	SP-2	PPG 97-682 Multiprime	1 (2.0 mils)	PPG 54 Line Alkyd Enamel Gloss	2 (2.0 mils each)	TBC	
16	PVC electrical conduit	SP-2	PPG 6-3 Alkali Resistant Primer	1 (2.0 mils)	PPG 54 Line Alkyd Enamel Gloss	2 (2.0 mils each)	TBC	
16	Electrical switchgear and Control Panels	SP-2	PPG 97-682 Multiprime	1 (2.0 mils)	PPG 54 Line Alkyd Enamel Gloss	2 (2.0 mils each)	TBC	Unless shop finished

NOTE:

* Min. Dry Film Thickness - mils per coat

** See preselected requirements for paint systems/colours (this Section).

*** PPG colour references quoted

**** The prime coat and two finish coats shop applied. For field touch-up, prepare surface as per Part 3. Hand or power-tool clean in accordance with relevant IS Code or manufacturers directions to remove loose or damaged coating. Dry abrasive blast all weld areas to be coated as per Part 3.

Also applies to steel flanges on stainless steel pipe.

***** Except as noted for specific machinery/equipment and appurtenances.

TBC To be chosen by the Engineer.

3.11 Colour Schedule - Items to be Chosen

ITEM **COLOUR**

General

1.	Exposed structural steel	- To be chosen later by Engineer
2.	Exposed miscellaneous steel	- To be chosen later by Engineer
3.	Exposed stands, operators,	- To be chosen later by Engineer
4.	Gear boxes, motors, etc	- To be chosen later by Engineer
5.	Exposed unfinished misc. metal and trim	- To be chosen later by Engineer
6.	Drains, vents, metal pipe and duct supports, cable trays, electrical conduits, etc.	- To be chosen later by Engineer
7.	Exposed surfaces of fans and shutters	- Match colour of adjacent wall and/or Ceiling.
8.	Items totally or partially submerged	- To be chosen later by Engineer

Building Items

9.	Floors, walls and ceilings	- To be chosen later by Architect (where colours not preselected)

Processing Piping, Equipment and Ducting

10.	Shop primed and/or factory finished equipment (including preselected items)	- To be chosen later by Engineer
11.	Steel/Cast Iron galvanized and Fabric jacketed surfaces including appurtenances	- To be chosen later by Engineer
12.	Exposed ducting-galvanized/fabric-jacketed surfaces	- To be chosen later by Engineer

3.12 Colour Schedule - For Preselected Colours

ITEM	SPEC. SECTION	SUPPLIER/ MANUFACTURER	COLOUR	REMARKS
Exterior block and brick – plastered	04200	Conform to 04200	To match existing immediate adjacent	Blocks to match existing Administration Bldg; of the Pumping Station.

ITEM	SPEC. SECTION	SUPPLIER/ MANUFACTURER	COLOUR	REMARKS
surface			buildings	
Aluminium Louvres	08400 & 08110 Division 10 Division 15	Conform to 09900	Subject to Architect selection	Louvres

3.13 Quality Assurance:

A. Perform surface preparation and painting using skilled technicians/painters using the materials and methods specified.

B. Workmanship and equipment used to be of the highest quality and subject to the approval of the Engineer.

3.14 Safety:

A. Comply with precaution measures outlined in Safety Act and Regulations for Construction Projects for the safety of workers.

3.15 Manufacturer's Inspection and Approval:

A. Submit written certification to the Engineer stating that the manufacturer's representative has examined the various surfaces prior to application and that the surfaces and the environmental conditions are suitable to receive the specified finishes. Provide this certification to this Engineer before starting work.

B. Submit to the Engineer, on completion of painting, written certification, signed by the respective manufacturers of products, stating the manufacturer's representative has inspected (at intervals) the application of paint products and that paint products have been applied satisfactorily and to the required coverage.

3.16 Product Delivery, Storage and Handling:

A. Deliver products to the site in original sealed containers, each labelled with the manufacturer's name, product name and catalogue number, colour and colour number, formula type, reducing instructions, and, where applicable, reference standard specifications number. Products delivered to the site must conform to products on the approved manufacturer's list of products.

B. Store materials at the site only in safe, secure, ventilated areas specifically set aside for paint product storage and protected from direct sunlight.

C. Provide a fully charged, ULC 10:BC rated, 20 kg carbon dioxide fire extinguisher in the storage area for the entire time materials are stored in the area.

END OF SECTION 09900.

SECTION 09950 WATER PROOFING ON TERRACE

PART 1 -GENERAL

1.01 Reference:

A. Section 09000 applies to and governs the work of this Section.

1.02 Work Included:

A. Supply and application of integral crystalline waterproofing for water retaining structures.

B. Supply and installation of three-layered waterproofing to terraces, layers consist of integral crystalline type waterproof base coat, second coarse of Brick bat Coba including grouting and third coarse of finishing with China Mosaic.

C. For schedule refer to Section 09900.

D. The Drawings, Datasheets and Specifications are intended to set the acceptable minimum standard.

1.03 Related Work:

A. The following related work is covered elsewhere in the Contract Documents:

1.	Division 3	-	Concrete
2.	Division 4	-	Masonry

1.04 Alternatives:

A. There are no alternatives applicable for this Section.

1.05 Submittals:

A. Submit product details of manufacturer's catalogues and data sheets for integral waterproofing compounds to be used for the work.

B. Waterproofing sub-contractor to submit his credentials and procedure of works to be executed.

1.06 Codes and Standards:

A. The following applicable standards established by the Bureau of Indian Standards govern the materials and workmanship of the work under this Section.

IS 2645 – 2005 Integral Water Proofing compounds for cement mortar and concrete specification.

B. Where provisions of the pertinent codes and standards conflict with these Specifications and Drawings or with each other comply with the more stringent provisions.

C. Use the latest issue of Standards.

PART 2 - PRODUCTS

2.01 General:

A. Comply with product requirements as specified by the manufacturer.

2.02 Materials:

A. Integral crystalline waterproofing compound from approved manufacturer.

B. Broken brick bats of size 20 mm to 10mm from good and thoroughly well burnt bricks.

C. China mosaic tiles of broken pieces of 6mm thick selected white / colour glazed tile pieces.

D. Cement, sand as per specification in Section 03300.

2.03 Storage:

A. Store crystalline waterproofing compound as per manufacturer's instructions and check expiry date before using the same.

2.04 Approved Suppliers / products for waterproofing compound:

A. Penetron

B. BASF

C. or equivalent as approved

PART 3 - EXECUTION

3.01 General:

A. Comply with the execution requirements as specified by the manufacturer.

B. Apply:

1. Consumption: Water retaining structures, internal concrete wall surfaces: Two coats of Crystalline Waterproofing Compound at 0.70 – 0.80 kg/m^2 and one coat at 1.40 – 1.70 kg/m^2 applied with brush or spray or as recommended by manufacturer.

2. Construction slabs: Waterproofing compound at 1.00 kg/m^2 applied in one slurry coat to hardened concrete or dry sprinkled and trowel applied to fresh concrete when this has reached initial set.

3. Construction joints: Crystalline waterproof compound at 1.7 kg/m^2 applied in slurry or dry powder consistency immediately prior to placing the next lift / bay of concrete.

4. Blinding concrete: Waterproof compound at 1.40 kg/m^2 applied in slurry or dry powder consistency immediately prior to placing the overlying concrete slab.

3.02 Surface Preparation:

A. All surfaces on which crystalline waterproofing compound is to be applied shall be thoroughly cleaned. Remove all loose concrete or mortar, brush clean the surface, expose visible cracks and make V groves. Remove oil and grease stains by brushing or sand blasting.

B. All concrete to be treated with integral crystalline waterproofing must be clean and have an open capillary system. Remove laitance, dirt, grease etc by means of high pressure water jetting, wet sandblasting or wire brushing. Faulty concrete in the form of cracks, honeycombing etc must be chased out, treated with water proofing compound and filled flush with cement mortar. Surfaces must be carefully pre-watered prior to the water proofing compound application. The concrete surface must be damp but not wet. Waterproofing treatment shall be taken up the parapet walls to a height of 300 mm.

C. Mixing:

1. Mechanically mix waterproofing compound with clean water to a creamy consistency or that resembling thick oil. Approximate mixing ratio is 2 parts

water to 5 parts water proof powder (by volume). Mix only as much material as can be used within 20 minutes and stir mixture frequently. If the mixture starts to set do not add more water. Re-stir to restore workability.

D. Application:

1. Slurry consistency: Apply waterproofing compound in three coats according to specification by masonry brush or appropriate power spray equipment. When three coats are specified, apply the second coat while the first coat is still green.

E. Dry powder consistency (for horizontal surface only). The specified amount of waterproofing compound is distributed in powder form though a sieve and trowelled into the freshly placed concrete once this has reached initial set.

F. Post treatment: The treated areas should be kept damp for curing a period of five days and must be protected against direct sun and wind by covering with polyethylene sheeting, damp burlap or similar.

G. Waterproofing compound cannot be used as an additive to concrete or plasters.

H. Technical Data:

Aggregate state	-	Powder
Colour	-	Cement Grey
Bulk density	-	Approx. 1.25kg/l

*All data are averages of several tests under laboratory conditions. In practice, climatic variations such as temperature, humidity and porosity of substrate may affect these values.

I. Water Retaining Structure: Prepare putty by mixing crystalline powder with water. Apply putty in v grove. After wetting the surface hard press putty in the groove. Cure for 3 to 7 days. Fix nozzles on construction joints and honeycomb areas and pressure grout it with water mixed with crystalline powder. Apply slurry made of crystalline powder and water in two coats perpendicular to each other, on all surfaces to be waterproofed from positive side. Cure the surface properly. The procedure is given for guidelines. The work shall be carried out under manufacturer's instruction and guidance.

J. Sunken Floor Slab:

1. Brickbat aggregate shall be from well-burnt bricks. The proprietary waterproofing compound and the quantity to be used shall be as specified above.

2. The surface shall be thoroughly cleaned with wire brushes. All loose scales, laitance shall be removed and dusted off. The surface bottom as well sides shall be applied with a coat of cement slurry admixed with proprietary water proofing compound to penetrate into crevices and fill up all the pores in the surface.

3. After the slurry coat is laid, a 20 mm thick layer of cement mortar not leaner than 1:5 (1 cement: 5 coarse sand) admixed with proprietary water proofing compound conforming to IS: 2645 shall be laid. Then a layer of well burnt brick bats of about 40mm size shall be laid in cement mortar of mix as specified by the specialist firm but not leaner than 1:5 (1cement: 5 coarse sand) admixed with proprietary water proofing compound, the mortar being filled to half the depth of the brick bat layer. The brickbat layer shall be rounded off at junction with the beam / wall etc., and tapered towards top to a

height of 150 mm along beam / walls etc. Curing of this layer shall be done for two days.

4. After curing, the surface shall be applied with a coat of neat cement slurry admixed with proprietary water proofing compound.

5. Joints of brick bat shall be filled fully with cement mortar of mix as specified by the specialist firm but not leaner than 1:4 (1cement: 4 coarse sand) admixed with proprietary water proofing compound and top finished with average 20mm thick layer of same mortar. This layer of mortar shall be continued to the sides of beam / wall of the sunk etc. The height upto that this treatment is to be extended on the sides shall be as directed by the Engineer-in-Charge. The surface shall be finished smooth with cement slurry admixed with proprietary water proofing compound. No chequers or false squares shall be marked on the finished surface.

6. While the water proofing treatment is done, it shall be ensured that the outlet pipes are properly fixed and the gaps between the wall and pipes are properly filled with brick / stone aggregate and cement mortar admixed with proprietary water proofing compound and grouted with cement slurry admixed with proprietary water proofing compound.

7. Waterproof treatment shall be cured for a minimum period of two weeks.

K. Terrace waterproofing:

1. Brick Bat Coba: The prepared surface shall be wetted, but ponding shall not occur. Spread cement slurry mixed with water. Trowel the same so that all hair line cracks are grouted. Cure for 6 days. Hand fix brickbat on 1:2 cement mortar to the required slope. Cure the same. On top spread 1:2 cement slurry mixed with ensuring that all joints are filled properly. Trowel finish the surface to the required slope. At junctions of wall and slab, prepare watta up to the height of 300mm. The surface shall be broom finished. Pond the entire terrace with water for testing purposes. The procedure is indicative and work is to be executed as per approved procedure.

L. China Mosaic Tiles:

1. Laying : Over the prepared surface of brick bat coba, a layer of cement mortar, 20mm, thick or as specified shall be laid and cement slurry of consistency of honey, shall spread over it using cement at a rate of not less than $0.01m^3$ per $10m^2$. While the bed is fresh, broken pieces of 6mm thick selected white / colour glazed tiles not less than 25mm and not more than 50mm. in any direction shall be set closely by hand at random. The glazed tile pieces shall be soaked in water before setting in position. The glazed surfaces shall be kept exposed and pressed with wooden mallet. Over the glazed tile pieces neat cement slurry, using cement not less than 0.01 m^3. Per 10 m^2 shall be spread and the surface brushed in and lightly rolled with wooden roller, taking care that no air pockets are left between brick bat coba and china mosaic flooring.

2. The top surfaces shall be cleaned with sawdust and cotton waste. Finally the surface shall be cleaned with weak acid solution to remove cement marks over the glazed tile pieces. The finished work shall be cured for at least 7 days. Care shall be taken to ensure that cement in joints does not dissolve due to acid washing. At corners and junctions with parapets, the water proofing course shall be rounded off with cement mortar.

M. Painting with Hot Bitumen:

1. The surface to be painted shall be thoroughly dried and shall be cleaned, with wire brushes and cotton or gunny cloth, of all loose materials and scales. The surface shall further be cleaned with a piece of cloth lightly soaked in kerosene oil. Bitumen shall be brought to the site in its original container and this shall not be removed from site till the painting job is completed. Before applying the main coatings of hot bitumen paints, one coat of bituminous primer shall be applied. The number of coats of hot bitumen shall be either two coats or as specified in the Schedule of Quantities. The bitumen of approved quality (either of grade 80/100 or 30/40) shall be applied to the surface after heating it to the manufacturer's specifications. Care shall be taken to see that no blank patches are left and the quality of bitumen to be spread shall be as specified and shall be to the satisfaction of the Engineer.

3.03 Quality Assurance:

A. Structures waterproofed shall be tested for water tightness as directed by Engineer. If any leakages are observed, rectify immediately. Deflect liability period for Water proofing shall be 5yrs and the contractor shall provide the same.

END OF SECTION 09950.

SECTION 09960 INTERIOR AND EXTERIOR ACRYLIC EMULSION PAINT

PART 1 -GENERAL

1.01 Reference:

A. Refer Section 09000 applies to and governs the work of this Section.

1.02 Work Included:

A. The work of this Section includes painting of exterior faces of the structure and site element surfaces, including but not limited to:

1. Concrete masonry block.
2. Poured or pre-cast concrete surfaces.
3. Shop and field application of primers and finish coats

B. Touch-up and repaint all painted surfaces damaged during construction.

C. Unless specified or otherwise noted, do not apply paint or protective coating to the following:

1. Copper stainless steel, chrome plate, plastic, aluminum, bronze, or brass surfaces.
2. Finishing hardware;
   a) Equipment nameplates and other such identification;
   b) Switches and other electrical device faceplates except if constructed of prime coat painted or galvanized steel, in which case they are to be painted;
   c) Lighting fixtures;
   d) Surfaces factory coated including epoxy or enamel finishes, unless specified otherwise;
   e) Plastic laminate surfaces;
   f) Glass;
   g) Tile products, glazed or unglazed, including quarry tile;
   h) Manhole covers;
   i) Covers or strainers associated with floor drains, cleanout terminations, and similar equipment;
   j) Recessed electrical boxes and similar recessed equipment;
   k) Control panels/unless specified otherwise.
   l) Circuit breakers, switches, receptacles and similar electrical devices, unless specified otherwise;
   m) Galvanized or plastic coated wire fencing; posts and accessories;
   n) Pre-finished metal and flashings - trim;
   o) Pre-finished louvres.

1.03 Related Work:

A. The following related work is covered elsewhere in the contract documents:

1.	Division 4	-	Masonry
2.	Division 5	-	Metals
3.	Division 8	-	Doors and Windows
4.	Section 09900	-	Painting

1.04 Alternatives:

A. Refer to Section 01002 for requirements pertaining to acceptance of alternatives.

1.05 Submittals:

A. Submit to the Engineer for review a complete list of materials listing proposed manufacturer, material designation and relevant identification data prior to ordering.

B. Provide only reviewed and approved material.

C. Submit standard colour chips of all types of paint to be used. The Engineer will approve all colours for use on this project.

1.06 Codes and Standards

A. The following applicable standards established by the Bureau of Indian Standards govern the materials and workmanship of the work under this Section.

IS : 2395 Indian Standard Code of practice for painting concrete, masonry and plaster surfaces.

B. Where provisions of the pertinent codes and standards conflict with these Specifications and Drawings or with each other comply with the more stringent provisions.

C. Use the latest issue of Standards:

PART 2 - PRODUCTS

2.01 General:

A. Coatings manufactured by approved manufacturers/suppliers, Premium acrylic emulsion interior and exterior lead free paint with anti algal and anti fungal properties shall be considered. For exterior paints the paint shall withstand extreme tropical condition of heavy rainfall, humidity and heat. The paint shall also withstand UV degradation and shall not fade. The Engineer will determine the specific equivalence of any proposed alternative product.

B. The paint shall exhibit excellent adhesion to plaster and cement surface and shall resist deterioration by alkali salts. The paint film shall allow the moisture in wall to escape without peeling or blistering. The dried paint surface shall be able to withstand washing with mild soap and water without any deterioration a colour, or without showing flaking, blistering or peeling.

C. Provide painting materials of the highest quality.

D. All painting materials and the minimum number of coats or applications of each type of material as manufacturer guidelines.

E. Provide thinners and cleaners for proper surface preparation recommended by the paint manufacturer for that particular finish paint.

F. Non-standard colours may be selected by the Engineer. Provide non-standard colours at no additional cost to the BMC.

G. Unless otherwise noted, paint or protective coatings are to be ready-mixed. Where site mixing is required for certain products, mix in strict accordance with the manufacturer's recommendations to produce smooth-flowing materials with an ease of application consistency.

2.02 Approved Manufacturers/Suppliers:

A. Asian Paints Ltd, Mumbai

B. Kansai Nerolac Paints Ltd

C. Or equivalent approved.

PART 3 - EXECUTION

3.01 Examination:

A. Examine surfaces to be finished before commencing work and advise the Engineer of any defective surfaces.

B. Correct defective surfaces before commencing work. Commencement of work implies the acceptance of the existing conditions.

3.02 Preparation:

A. Prior to beginning the coating work, clean all surfaces free of rust, corrosion, dirt, dust, grease or any extraneous matter.

B. Vacuum clean areas inside the building immediately prior to commencing finishing work.

C. Do not apply finishes on damp, wet or dirty surfaces.

D. Be responsible for taking all precautions or protective measures that may be necessary to suit the prevailing environmental conditions (excessive heat, humidity, spray etc) as they may affect the work of this Section.

E. Deliver all paint materials to the site in unbroken, sealed, clearly labelled original containers.

F. Acid etch smooth concrete surfaces to achieve better paint or protective coating adhesion. Comply with paint manufacturer recommendations.

G. Prepare plaster surfaces as specified by manufacturer.

H. Test surfaces for moisture content with an electronic moisture meter and test concrete, masonry and gypsum surfaces for acid-alkali balance.

I. Maintain at the site at all times until the work is completed, a moisture meter, hygrometer and thermometer to verify surface and environmental conditions.

J. Apply finishing materials at proper consistency, free from brush marks, sags, crawls, streaks, runs, laps, skips, voids, pinholes, missed areas and other perceptible defects, and with even colour, sheen and texture.

K. Apply finishing and coating materials to provide full coverage and at a rate to provide the dry film thicknesses specified, but not to exceed that recommended by the manufacturer for the applicable surface.

L. Make clean, true junctions with no overlap between adjoining applications of finish coatings.

M. Leave all parts of mouldings and ornaments clean and true to details with no undue amount of coating in corners and depressions.

N. Use materials of a single manufacturer in coating system.

O. Apply each coat only after the preceding coat is dry and hard or as otherwise directed by the material manufacturer.

P. Prior to the application of special finishes and coatings, arrange for a meeting at the site with the Engineer, the painting sub-contractor and a representative of the special finish(es) manufacturer(s) to discuss the condition of surfaces to receive special finish, and application procedures.

Q. Scrub and treat mildewed surfaces with a solution of trisodium phosphate bleach with a solution of one part sodium hydrochloride (Javex) to three parts water and rinse with clean water.

R. Prepare surfaces to be painted or coated such that the surfaces are thoroughly dry and free of chemicals, mortar splatters, organic matter, oil, grease, rush, scale, loose paint or any other material and such that the surfaces are in a proper condition to receive the coating.

3.03 Application:

A. External Wall

1. Paint shall be applied on properly primed surface.
2. Subsequent coats shall not be applied till the previous coat is dry.
3. Apply no. of coats as per manufacturer's recommendations.

B. Internal Wall

1. Apply putty to rectify unevenness in surface
2. Paint shall be applied on properly primed surface.
3. Subsequent coats shall not be applied till the previous coat is dry.

4. Apply no. of coats as per manufacturer's recommendations.

C. Apply all paint/stain material and protective coating finish in strict accordance with latest IS Code and the manufacturer's recommendations and as specified herein. In the event of any conflict in specifications, the more stringent specifications apply.

D. Do not field blend colours unless approved in writing by the Engineer.

3.04 Protection:

A. Cover or mask surfaces adjacent to those receiving treatment and finishing to protect the work of others from damage and soil. Mask instruction and specification plates and controls attached to equipment being painted.

B. Take particular care in storage and mixing areas to ensure that surfaces are protected.

C. Co-ordinate with the appropriate sub-contractors for the removal from finished surfaces, storage and reinstallation after finish work is completed of finish hardware, switches, plates, escutcheons, luminaire frames and similar items.

D. Post No Smoking signs and ensure that spark-proof electrical equipment is used in areas where flammable painting materials are being applied or stored.

E. Post Wet Paint signs throughout freshly finished areas and removed when finishes are dry.

F. Provide portable ULC 10: BC rated, 8 kg carbon dioxide fire extinguisher at work areas and where paint is stored.

3.05 Touch-up Surfaces:

A. Clean areas are to receive touch-up paint as specified.

B. Sand lightly to clean area for spot painting and apply two finish coats to match original coating specification.

C. Provide touch-up paint of all types and colours used on this work, suitably identified, for future use by the plant operating personnel.

3.06 Clean-up:

A. Upon completion, remove all materials and debris from the buildings.

B. Carefully clean work and remove paint from adjoining surfaces, glass, hardware etc. The whole shall be left in a condition satisfactory to the Engineer.

3.07 Quality Assurance:

A. Perform surface preparation and painting using skilled technicians/painters using the materials and methods specified.

B. Workmanship and equipment used to be of the highest quality and subject to the approval of the Engineer.

3.08 Safety:

A. Comply with precautionary measures specified in Section 01011 and 01005, for the safety of workers.

END OF SECTION 09960.

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SECTION 10000 SPECIALS

PART 1 -GENERAL

1.01 Governing Conditions:

A. The General Conditions, Particular Conditions, Contract Forms, Instruction to Bidder, and the requirements of Division 1 herein before specified, in addition to any and all Addenda, apply to and govern each Section of this Division.

B. This Section of this Division shall be read in conjunction with other Sections in this Division.

C. This Section governs the work of all other Sections in this Division.

1.02 Work Included:

A. Supply and installation of Special Items such as soil pans, urinals, louvres, plastic water storage tanks, PVC pipes, marble partitions etc and other works as specified.

B. Provide labour, materials and equipment necessary to complete installation of special items.

C. The Drawings, Datasheets and Specifications are intended to set the acceptable minimum standard.

1.03 Co-ordination:

A. Co-ordinate before installing work included in this Division. If work is installed without co-ordination with other works, the Engineer may direct that such work be removed, relocated and/or modified as necessary. Comply promptly with any Engineer's requests. Complete any correction and/or additional work, as directed by the Engineer.

B. For coordination requirements refer to Section 01003.

1.04 Submittals:

A. Submit shop drawings/sample for Special items in this Division in accordance with Section 01007, and As-Built Drawings as per Section 01016.

1. Deviations to technical specification
2. Suppliers catalogues/samples

1.05 Codes and Standards:

A. The applicable standards established by the Bureau of Indian Standards govern the materials and workmanship of the work under this division.

B. Where provisions of the pertinent codes and standards conflict with these Specifications, Drawings and Datasheets or with each other, comply with the more stringent provisions.

C. Use the latest issue of Standards.

PART 2 - PRODUCTS

2.01 General:

A. Comply with product requirements outlined in the individual Sections. Select all other materials, not specifically described but required for the proper completion of this Division, subject to the approval of the Engineer.

PART 3 - EXECUTION

3.01 General:

A. Comply with execution requirements outlined in the individual Sections.

END OF SECTION 10000

SECTION 10210 ALUMINIUM LOUVERS

PART 1 -GENERAL

1.01 Reference:

A. Section 10000 –applies to and governs the work of this Section.

1.02 Work Included:

A. Supply and installation of all exterior aluminum louvers including structural supports or frames, as specified and as shown on the drawings.

B. The Drawings, Datasheets and Specifications are intended to set the acceptable minimum standard.

1.03 Related Work:

A. The following related work is covered elsewhere in the contract documents:

1. Division 4 - Masonry
2. Division 5 - Metals

1.04 Alternatives:

A. Refer to Section 01002 for requirements pertaining to acceptance of alternatives.

1.05 Submittals:

A. Submit drawings and product data in accordance with Section 01007, and As-Built drawings as per Section 01016.

B. Submit to the Engineer, samples of storm-proof louvers, drainable louvers and aluminum heavy-duty bird screens.

1.06 Codes and Standards

A. The following applicable standards established by the Bureau of Indian Standards govern the materials and workmanship of the work under this section.

1	IS: 1038	Specifications for Steel, Doors, Windows and Ventilators.
2	IS: 4021	Specifications for Timber, Door, Window and Ventilator Frames.
3	IS: 1948	Specification for aluminium door windows and ventilators

B. Where provisions of the pertinent codes and standards conflict with these Specifications and Drawings or with each other comply with the more stringent provisions.

C. Use the latest issue of Standards.

PART 2 - PRODUCTS

2.01 Materials:

A. Louvre frames and blades shall be extruded aluminium alloy 6063 - T52 sections, minimum 8-gauge material; louvre depth shall be 150 mm unless otherwise specified.

B. Louvres up to 600 mm high shall have fixed horizontal storm proof blades and shall be 35 degrees from horizontal, complete with water baffle.

C. Louvres over 600 mm high shall have fixed horizontal drainable blades with gutters designed to catch and direct water to jamb and mullion drains.

D. Frames shall be of all-welded construction and shall be provided with a caulking recess all around.

E. Provide 13 mm x 13 mm intercrimped aluminium heavy-duty bird screens (2.3 mm gauge) folded in extruded aluminum frames on all louvers, mounted on the interior.

F. Storm proof louvers shall be approved by the Engineer. Continuous blade louvers to be used with continuous blade mullions where required.

G. Colours: to match the Pumping Station.

H. Drainable louvers shall be approved by the Engineer. Continuous blade louvers to be used with continuous blade mullions where required.

I. Refer to Section 09900 for colour selection.

2.02 Approved supplier / manufacturer

A. Srinathji Aluminum Louvers, Chennai

B. Rathod Industries, Mumbai

C. Yogeshwar Enterprises, Thane

D. Or equivalent approved.

PART 3 - EXECUTION

3.01 Examination:

A. Prior to ordering, carefully verify that building openings have the required dimensions.

B. In the event of a discrepancy, immediately notify the Engineer.

3.02 Installation:

A. Install louvers plumb and true, flush with the outside of building surfaces or as detailed on the Drawings.

B. The structural support or frame shall be designed by the louver manufacturer to support the louver against a wind load of not less than 1.0 kPa with the maximum deflection not exceeding 1/180 of the span.

C. Upon completion of installation, all louvers shall be left clean and free from dirt. All debris shall be removed from the site.

D. Replace or repair any scratches, dents or other damage to the louvers using manufacturer’s recommended methods and to the satisfaction of the Engineer.

END OF SECTION 10210.

SECTION 10430 SIGNAGE

PART 1 -GENERAL

1.01 Reference:

A. Section 10000 applies to and governs the work of this Section.

1.02 Work Included:

A. Provide all labour, material and equipment necessary to supply and install bronze identification signage - “New (Name of pumping station)” - including concealed anchors and all other work specified herein.

B. Supply and install lettering on building face at the location as per Engineer’s instructions.

1.03 Related Work by Other Divisions:

A. The following related work is covered elsewhere in the Contract Documents:

1.	Division 4	-	Masonry
2.	Division 5	-	Metals

1.04 Alternatives:

A. Refer to Section 01002 for requirements pertaining to acceptance of alternatives.

1.05 Submittals:

A. Submit drawings of all products specified in accordance with Section 01007.

B. Shop drawings shall clearly indicate all component parts and fixings, the materials being supplied, the thickness of the materials and shall show all connections, attachments and anchorage.

C. Shop drawings shall incorporate exact graphic layout and final accurate art work for the signage.

D. Submit two samples of 250 mm high letters in the material finish and font specified.

E. Submit maintenance instructions for the bronze signage in accordance with Section 01016.

1.06 Codes and Standards:

A. The applicable standards established by the Bureau of Indian Standards govern the materials and workmanship of the work under this Sections.

B. Where provisions of the pertinent codes and standards conflict with these Specifications and Drawings or with each other comply with the more stringent provisions.

C. Use the latest issue of Standards.

PART 2 - PRODUCTS

2.01 Materials:

A. Cast bronze letters, 250 mm high and with a 13 mm deep return. Lettering shall be in upper case and font style to be approved by Engineer. Letters shall have a 13 mm offset from the wall with spacers. Texture to face and sides of letters shall be sandblasted. Finish remaining uncoated natural bronze. Manufacturer to be reputable approved by Engineer.

B. Letters shall be mounted onto face of exterior concrete / masonry wall as approved by the Engineer. Horizontal bands of letters shall be centred within the 190mm high

block courses. Mounting shall be by way of studs into tapped bosses on backs of letters. Fill holes with quick-sealing cement.

2.02 Approved Manufacturer / Supplier for Bronze sheets

A. R. Mahveerchandra and Company, Mumbai

B. P.B. Corporation, Ahemdabad

C. Prolite Autoglow Mumbai

D. Delux Metal Industries, Ahmedabad

E. Or equivalent approved.

PART 3 - EXECUTION

3.01 Fabrication:

A. The outline of exterior exposed surfaces shall be exactly as indicated on the approved shop drawings.

B. Nuts, bolts, crews, clips and other means of fastening shall be concealed in the finished exposed work.

C. The finishes of the various materials shall be exactly as specified.

D. The dimensional tolerances shall be maintained with the closest accuracy for the various parts.

3.02 Installation:

A. Install sign at the location as per Engineer's instruction.

B. Install as per these Specifications and manufacturer's recommendations and guidelines.

C. Erect signs securely, plumb and square.

D. Fabricate and install signage in such a manner as to provide a permanently rigid and true installation.

E. Individual letters to be true, tight, flat and in alignment to the satisfaction of the Engineer.

3.03 Cleaning:

A. Clean and buff signs and leave in a neat appearance.

3.04 Maintenance Instructions:

A. Provide instruction on proper care and maintenance of the bronze signage.

3.05 Guarantee/Warranty:

A. The Guarantee/Warranty shall be for a period of five years from the date of Completion of Work.

B. The Guarantee/Warranty shall cover the repair of the bronze signage as a result of faulty materials or workmanship due to:

1. Loosening of units
2. Deforming failure in sign letters

C. Upon written notification that the signage is defective, promptly repair or replace the defective work.

END OF SECTION 10430

SECTION 10500 LOCKERS

PART 1 - GENERAL

1.01 Reference:

A. Section 10000 – applies to and governs the work of this Section.

1.02 Work Included:

A. Supply and install new steel lockers, accessories and finish metal trim for each Pumping Station.

1.03 Related Work:

A. The following related work is covered elsewhere in the Contract Documents:

1. Division 5 - Metals

1.04 Alternatives:

A. Not applicable for this Section.

1.05 Submittals:

A. Submit shop drawings, fabrication drawings, installation drawings and product data in accordance with Section 01007.

B. Submit drawings showing locker types, size and quantities, including all necessary details relating to anchoring, trim installation and relationship to adjacent surfaces.

1.06 Codes and Standards:

A. The following applicable standards established by the Bureau of Indian Standards govern the materials and workmanship of the work under this section.

IS: 800	Code of practice for use of structural steel in general building construction
IS: 226	Structural Steel (Standard quality)
IS: 961	Structural steel (High Tensile)
IS: 1977	Structural Steel (ordinary) - Fe 410-0
IS: 2062	Structural steel (Fusion Welding quality)
IS: 1079	Specifications for light gauge structural quality hot rolled carbon steel sheet and strip.

B. Where provisions of the pertinent codes and standards conflict with these Specifications and Drawings or with each other comply with the more stringent provisions.

C. Use the latest issue of Standards.

PART 2 - PRODUCTS

2.01 Materials:

A. Products supplied by manufacturers shall be approved provided they meet the detailed specifications written below.

2.02 Lockers:

A. Style: Four Tier.

B. Type: Single Door.

C. Size: 380 mm (w) x 450 mm (d) x 1830 mm (h)

D. No of Locker frames: 3

E. No. of Locker Openings: 12 nos

2.03 Fabrication:

A. Specified locker components shall be manufactured from galvanised steel and finished by manufacturer's standard process.

2.04 Finish:

A. Surfaces of the steel shall be thoroughly cleaned and phosphatized in a seven-stage process.

B. All parts shall then be finished with a heavy coat of Epoxy Polyester Powder to thickness of 50 microns (± 10).

C. Provide to the Engineer colour charts showing manufacturer's available colours.

2.05 Construction:

A. Lockers shall be built on the unit principle - each locker shall have an individual door and frame, an individual top, bottom, back and shelves with common intermediate uprights separating units.

B. Provide rigid knock-down construction for locker.

2.06 Door Frames:

A. Door frames shall be 16 gauge formed into 25mm wide face channel shapes with a continuous vertical door strike, integral with the frame on both sides of the door opening.

Four tier locker cross frame members shall be 16 gauge channel shaped securely welded to vertical framing members to ensure a square and rigid assembly. Intermediate cross frame members are not required on box lockers.

2.07 Doors:

A. Provide door with 16 gauge or 18 gauge steel as required by manufacturer's design, formed with a full channel shape on the lock side to fully conceal the lock bar, channel formation on the hinge side and right angle formation across the top and bottom.

B. Locker doors shall be ventilated by louvres on the face of each door, top and bottom.

2.08 Pre-Locking Device:

A. All lockers shall be equipped with a positive automatic pre-locking device, whereby the locker may be locked while door is open and then closed without unlocking and without damaging locking mechanism.

B. Provide 10 lever cam lock with lock lever built in and three keys for each locker.

2.09 Handles:

A. A non-protruding 14 gauge lifting trigger and slide plate shall transfer the lifting force for actuating the lock bar when opening the door.

B. The exposed portion of the lifting trigger shall be encased in a moulded ABS thermoplastic cover that provides isolation from metal-to-metal contact and be contained in a formed 20 gauge stainless steel recessed pocket. This stainless steel pocket shall contain a recessed area for the various lock types available and a mounting area for the number plate.

2.10 Hinges:

A. Hinges shall be 50 mm high, 5-knuckle, full loop, tight pin style, securely welded frame and double riveted to the inside of the flange. Locker doors 1050 mm high and less shall have two hinges. Doors over 1050 mm high shall have three hinges.

2.11 Body:

A. The body of the locker to consist of 24 gauge upright sheets, backs, tops, bottoms and shelves. Tops, bottoms and shelves to be flanged on all four sides; backs to be flanged on two sides. Uprights shall be offset at the front and flanged at the rear to provide a double-lapped rear corner. All bolts and nuts shall be stainless steel.

2.12 Interior Equipment:

A. Single tier lockers over 1060 mm high shall have one hat/ book shelf. Other tiered lockers do not require shelves. All single, double and triple tier lockers shall have one double prong rear hook (single prong in 230 mm width) and two single prong wall hooks in each compartment. All hooks shall be made of steel, formed with ball points, zinc-plated and attached with two bolts or rivets. Lockers under 510 mm high shall not be equipped with hooks.

2.13 Number Plates:

A. Each locker shall have a polished aluminium number plate with black numerals not less than 38mm high. Plates shall be attached with rivets to the lower surface within the recessed handle pocket.

B. Provide number system in English and Marathi as per approved shop drawings.

2.14 Colour:

A. Doors and exposed body parts to be finished in selected colours, approved by the Engineer.

2.15 Hanging Rod

A. One hanging rod in each component.

2.16 Accessories:

A. Stand for lockers – 125 mm high inclusive of leveller.

2.17 Approved supplier / manufacturer

A. Godrej & Boyce, Mumbai

B. Or equivalent approved.

PART 3 - EXECUTION:

3.01 Installation:

A. Lockers shall be installed in accordance with the manufacturer's approved shop drawings and assembly instructions.

B. Installation shall be level and plumb with flush surfaces and rigid attachment to anchoring surfaces on the stand.

3.02 Adjustment:

A. Upon completion of installation, inspect lockers and adjust as necessary for proper door and locking mechanism operation.

B. Touch up scratches and abrasions with factory-supplied paint to match original finish.

C. For user safety, all lockers must be secured to the wall and/or floor prior to use.

3.03 Inspection:

A. Lockers will be inspected at site for gauge thickness of door and body and proper closing of lockers.

END OF SECTION 10500.

SECTION 10802 WASHROOM ACCESSORIES

PART 1 -GENERAL

1.01 Reference:

A. Section 10000 - applies to and governs the work of this Section.

1.02 Work Included:

A. Provide washroom accessories as specified hereinafter and as shown on the Drawings.

B. The Drawings, Datasheets and Specifications are intended to set the acceptable minimum standard.

1.03 Related Work by Other Divisions:

A. The following related work is covered elsewhere in the contract documents:

1.	Division 4	-	Masonry
2.	Division 5	-	Metals
3.	Division 9	-	Finishes
4.	Division 15	-	Mechanical
5.	Section 15400	-	Plumbing and Drainage.

1.04 Alternatives

A. Refer to Section 01002 for requirements pertaining to acceptance of alternatives.

1.05 Submittals:

A. Submit catalogues, product data documents as specified in section 10000 in accordance with Section 01007, and As-Built drawings as per Section 01016.

1.06 Codes and Standards:

A. The applicable standards established by the Bureau of Indian Standards govern the materials and workmanship of the work under this section.

B. Where provisions of the pertinent codes and standards conflict with these Specifications and Drawings or with each other comply with the more stringent provisions.

C. Use the latest issue of Standards.

PART 2 - PRODUCTS

2.01 Materials:

A. All materials as manufactured by approved manufacturers unless otherwise specified shall be provided in each wash room.

B. European pattern coloured white porcelain floor mounted soil pan 630 mm long of an approved make and pattern with trap and antisyphonage opening for vent pipe, 32mm dia. PVC seat cover with brass hinges. PVC cistern double-flush type with anti-microbial 3/6litres flushing capacity. Including CP stop cock, brass unions, jam nuts, GI/PVC flush pipes with plug bends with cleaning cap from soil pan to soil pipe, including fitting.

C. Flat base urinal in white glazed earthenware fixed with screw, P trap and 32mm PVC drain pipe, fitted with CP spreader with CP stop cock.

D. Polyethylene water storage tank of the required capacity, having ISI mark, approved make such as Sintex, Ashish Plast or equivalent with mosquito-proof brass jali frame

and cover, 450mm with locking arrangement including required copper ball lock with brass arm including washout plug and overflow GI pipe with mosquito-proof jali.

E. Marble partitions of approved quality and grain 15mm thick highly polished on both sides with round edges and holes cut in the same to receive flushing pipe etc. as directed.

F. 100mm dia, 4mm thick (wt. approx.10 kg/m) centrifugally cast CI pipes, socket/spigot soil waste and ventilation purpose including specials such as cut pipes, bends, offsets and shoes.

G. White / coloured porcelain 550 mm wash basin with wall products of an approved make with overflow, sensor tap with touch-free operation, wastewater pipe, required P trap complete in all respects. Size 530 mm x 345 mm with 140 mm depth.

H. Automatic Hand Dryer

1. Stainless steel hand dryer, of grade SS-316, non-magnetic RPM-9000, Drying time less than 10 sec, time protection – 1 minute auto cut, Size 240 x 270 x 142 mm.

I. Liquid Soap Dispenser

1. Stainless steel AISI-316 soap dispenser and fitted to give classy appearance to wash room-capacity – 100ml.

J. Hand Towel Dispenser

1. Stainless steel paper dispenser, capacity – 450 – 500 tissues wall-mounted.

K. Double Roll Tissue Dispenser with Shelf

1. Manufactured using quality toilet tissue grade, serrated edges for smooth, single hand dispensing various length, pin-to-pin embossing pattern.

L. Glass Mirror

1. 600 X 450 mm, 6 mm thick bevel edged float glass mirror manufactured by Mode or equivalent mounted on 10 mm thick waterproof plywood with SS screws.

2.02 Approved suppliers / manufacturer

A. Euronics Industries

B. Parryware

C. Neelkamal, Mumbai

D. Or equivalent approved.

PART 3 - EXECUTION

3.01 Installation:

A. Install all items to the satisfaction of the Engineer.

END OF SECTION 10802.

SECTION 17001- REPAIR WORKS

PART 1 -POLYMER MODIFIED CEMENT MORTAR

1.01 General

The cement-based polymer modified mortar shall be prepared at the site by adding blended cement, polymer and aggregate or using ready to use components supplied by manufacturer's in pre-packed containers/ bags subject to approval of engineer. The polymer must be brought at the site in sealed packed containers directly from the manufacturer/source as specified and directed by the consultants.

1.02 QUALITY ASSURANCE LABELING

Contractor shall clearly mark all containers with following information

a. Name of manufacturer

b. Manufacturer's product identification

c. Manufacturer's instruction for mixing

d. Warning for handling and toxicity

1.03 APPLICATION CONTROL

The contractor shall submit mixing application procedure for approval prior to use.

1.04 DELIVERY OF MATERIAL

Contractor shall deliver all materials in sealed containers with labels legible and intact.

1.05 STORAGE OF MATERIAL

Contractor shall arrange to store all materials a t the temperature recommended by the manufacturer and as directed by the consultants.

1.06 MATERIALS

The CEMENT used shall be blended cement conforming to IS:8112. IT must be free from any lumps and must be from fresh stock.
The sand shall be sharp washed, well graded and free from excessive fines. Quartz sand 1630 mesh size shall be used for all polymer modified work.
Water used for cementitious polymer modified mortar shall conform to the requirement of IS:456.
Polymer used shall be Acrylic base.

1.07 EXECUTION

A. PREPARATION OF CONCRETE SURFACE

A good base or foundation shall be prepared for successful application of polymer concrete.
Proper support must be provided to members under repair before exposing the same for repair. It is mandatory for the contractor to seek consultant's approval for the support system. The ultimate responsibility of the support system lies with the contractor. The gist of the point being the paramount importance of the safety of the building under repair.
The props must be tight against any jerks or jolts. The system should ensure that all loads of slab, beams and overhangs are properly redistributed by by-passing the column to be repaired. Necessary length of the wall, if required can be dismantled.
All unsound/ weak concrete material shall be first removed upto the required depth including undercut upto 6 mm behind the reinforcement bars, wherever required as directed by the Engineer. Chipping shall continue until there are no offsets in the cavity will cause an abrupt change in the thickness of the repaired surface.

While removal of cover, care is to be taken that the sound core of the column is not disturbed.

Exposed corroded steel is to be cleaned thoroughly by chipping hammer and wire brush. The steel surface is to be evenly coated twice by any rust converter in 4 hours interval and must be cleaned with running water after 12 hours. Subsequently, two coats of Rust pasivator of Polymer: Cement should be applied on cleaned reinforcement in 4 hours interval.

After it has been ensured that surface to which polymer modified cement mortar is to be bonded is sound, it shall be cleaned off all loose and foreign materials by means of wire brushing as directed by engineer.

B. METHODOLOGY

i. BOND COAT

The contractor shall wet the surface ensuring that they are saturated but free of surface water. Prepare a bonding slurry of 1.5 to 2 part of cement to 1 part of polymer mixed to a lump free creamy consistency. Alternatively, the primer (bonding slurry) shall be made as per manufacturer's recommendations. The bonding slurry shall be worked well into the surface of the parent body using stiff brush ensuring that no pinhole are visible. Bonding slurry shall not be applied at a thickness in excess of 2 mm. If in the opinion of engineer a second coat is necessary, the same shall be applied after the first coat is touch dry. The second coat shall be applied at right angle to the first to ensure complete coverage. The bonding slurry shall be applied to prepare a concrete and reinforcement substrate after tying in new reinforcement wherever specified in the form of bars or welded wire fabric. Cement base polymer modified mortar shall be applied as soon as possible after application of bonding slurry but always during the open time of adhesive.

C. APPLICATION OF POLYMER MORTAR

Mixing of polymer with cement shall be done in proportion as recommended by manufacturer. Normally, 10 kg of polymer is to be mixed with 50 kg of cement.

The mixing shall be carried out in efficient concrete mixer. However, the Engineer may allow hand mixing in case total weight of mix per batch is less than 25 kg. Polymer must be prepared in a water tight G.I. tray.

The mixer shall be charged with required quantity of sand and cement and pre-mixing shall be carried for approximately one minute.

Rendering of cement based Polymer modified mortar shall be done immediately after applying the bonding slurry to the prepared surface preferably in coats of approximately 12-15 mm thickness, as greater thickness may lead to slumping. Further coats shall be applied fairly in rapid succession immediately after the previous layer gets set hard enough to receive the subsequent layer. After application of mortar the surface shall be either finished by impregnating 20 mm down graded metal pieces or closed using a wooden float or steel trowel and furrowed subsequently, while the mortar is still green. In case the thickness of damaged concrete is more than 12-15 mm, the first layer must be applied using quartz sand and subsequently layers can be built using thoroughly cleaned river sand and 10 mm down metal. A proper bond coat must be applied prior to application of each layer of polymer modified cement mortar.

D. INSPECTION AND QUALITY CONTROL

The mortar application work shall be continuously inspected by a qualified supervisor, who shall check materials, application of mortar, curing, etc.

Each completed work shall be systematically sounded with a hammer to check for drummy areas after hardening. In suspected areas or whenever directed by Engineer, contractor shall drill the cores from the finished work after 7 days and 28

days of mortar application. The cores shall be examined for evidence of poor workmanship by the engineer and if he feels that either bonding work or the subsequent layer of mortar are not required workmanship, the contractor at the instruction of the engineer shall dismantle such areas of work as required by the Engineer and redo the same after re-preparing the surface by chipping of mortar work and abrading the bonding slurry interface. Fogging to be carried out for atleast 4-5 days.

E. PAYMENT

Measurement shall be in sqm/swft basis of the actual exposed surface for repairs. All the measurement shall be taken before starting application work of polymer modified cement mortar. The corner of the P.C.M. work to be measured once, with one side only.

The rate shall include the cost of treatment given to old and new reinforcement and application of bond coat to exposed concrete surface and every successive layers.

Quartz sand shall be supplied by the contractor.

The rate is exclusive of providing and fixing of steel reinforcement.

The rate shall include the cost of scaffolding and working platform at all height and level.

The polymer consumption shall be strictly reconciled @ 200 gm/ per sft or 2.20 kg/ sq.m for all kind of repair work.

Incase of polymer consumption is exceeding more than 20% i.e. specified dose the same should be brought to the notice of consultants maximum within 3 days in writing, failing which it will be considered as a wastage of polymer and the extra consumption of polymer shall be borne by contractor only. Similarly, in case polymer consumption is less than that specified i.e. more than 20% shall be considered as a manipulation of measurement or poor grade or work due to less consumption of polymer.

PART 2 -JACKETING

2.01 PREPARATION OF SURFACE

A good base or foundation shall be prepared for successful application of jacketing.

Proper support must be provided to members under repair before exposing the same for repair. IT s mandatory for the contractor to seek consultant's approval for the support system. The ultimate responsibility of the support system lies with the contractor. The gist of the point being the paramount importance of the safety of the building under repair.

The props must be tight against any jerks and jolts. The system should ensure that all load of slab, beams and overhangs are properly redistributed by bypassing the column to be jacketed. Necessary length of wall etc. can be dismantled.

All sound/ weak concrete material shall first be removed up to the required depth as directed by Engineer. Chipping shall continue until there are no offsets in the cavity, which will cause an abrupt change in thickness of repaired surface.

Exposed corroded steel is to be cleaned thoroughly by chipping hammer and wire brush. The steel surface is to be evenly coated twice by any rust converter in 4 hours interval and must be cleaned with running water for 12 hours. Subsequently, two coats of Rust Passivator of Polymer: Cement should be applied on cleaned reinforcement in 4 hours interval.

After it has been insured that the surface to which jacket concrete is to be bonded is sound, holes of required depth and diameter shall be drilled using heavy dity "BOSCH" hammer dirll as per the spacing stated. The drilled holes shall be thoroughly cleaned off loose particles by oil free air blast. The treated steel bars of required length, shape and diameter shall then be driven inside the hole, packed with polymer mortar.

A polymer dash coat must be applied at least one day prior to casting of Jacket, impregnating 20 mm down metal pieces.

2.02 CASTING OF JACKET

Steel reinforcement is to be provided after proper binding, bending, etc. as specified by the Engineer. Hole to be drilled in the slab to pass the reinforcement to maintain the continuity of R.C.C. jacket. Proper form work/ shuttering is to be provided all around the column so as to provide a R.C.C. jacket. The jacket so provided will be min of 75 mm thickness over the R.C.C. Column/ beam and the same to be filled with M25 grade of concrete using super plasticizer to avoid honeycombing effect. Any kind of honey comb, if appeared after opening of shuttering next day, must be repaired as per the instruction of Engineer in charge at no cost to society.
All form work/ shuttering is to be removed min after 24 hours. The jacketed portion is to be cured properly for 7 days using gunny bags to cover new concrete surface. All steel props to be removed and load re-transformed as per the instruction of the Engineer all complete including any incidental work if required.

2.03 PAYMENT

Payment of jacketing shall be made on the basis of unit rate quoted in the schedule of quantities.
Measurement of jacketing shall be based on SqM of actual work done. The comer of jacket to be measured once, with one side only.
The rate shall include providing and fixing shuttering with all necessary support, platform, surface preparation, treatment to reinforcement, curing, using of super plasticizer and any other incidental work as required.
Nothing extra shall be paid for additional thickness of concrete if any, required to fill the excessive damaged cover/ core concrete.
Relieving of load from R.C.C. column and beam shall be paid separately under relevant item.
The rate shall exclude providing and fixing of reinforcement, which shall be paid under relevant item.
Rate is inclusive of applying polymer dash coat and impregnating metal pieces if required, but exclusive of cost of polymer, which shall be paid separately.
The rate should be inclusive of breaking of floor, P.C.C, removing of stone boulder, excavation in soil and backfilling the same after completion of jacketing work.

PART 3 -REPAIRS TO PLASTER

The work includes cutting the patch and preparing the wall surface. Patches of 2.50 square metres and less in area shall be measured under item of 'Repairs to Plaster' under this sub-head.
Plastering in patches over 2.5 square metres in area shall be paid for at the rate as applicable to new work under sub head Finishing'.

3.01 SCAFFOLDING

Scaffolding as required for the proper execution of the work shall be erected. If work can be done safely with the ladder or jhoola these will be permitted in place of scaffolding.

CUTTING

The mortar of the patch, where the existing plaster has cracked, crumbled or sounds hollow when gently tapped on the surface, shall be removed. The patch shall be cut out to a square or rectangular shape at position marked on the wall as directed by the Engineer-in-Charge or his authorized representative. The edges shall be slightly under cut to provide a neat joint.

3.02 PREPARATION OF SURFACE

The masonry joints which become exposed after removal of old plaster shall be raked out to a minimum depth of 10 mm in the case of brick work and 20 mm in the case of stone work. The raking shall be carried out uniformly with a raking tool and not with a basuli, and loose mortar dusted off. The surface shall then be thoroughly washed with water, and kept wet till plastering is commenced.

In case of concrete surfaces, the same shall be thoroughly scrubbed with wire brushes after the plaster had been cut out .

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

In case of concrete surface if a chemical retarder has been applied to the form work, the surface shall be roughened by wire brushing and all the resulting dust and loose particles cleaned off and care shall be taken that none of the retarders is left on the surface.

APPLICATION OF PLASTER

Mortar of specified mix with the specified sand shall be used. The method of application shall be as described for single coat plaster work of the specified mix and under SP-CS-PL-05. The surface shall be finished even and flush and matching with the old surrounding plaster. All roundings necessary at junctions of walls, ceilings etc. shall be carried out in a tidy manner as specified in sub-head SP-CS-PL-05.

All dismantled mortar & rubbish etc. shall be disposed off within 24 hours from its dismantling promptly as directed by the Engineer-in-Charge.

PROTECTIVE MEASURE

Doors, windows, floors, articles of furniture etc. and such other parts of the building shall be protected from being splashed upon. Splashing and droppings, if any, shall be removed by the contractor at his own cost and the surface cleaned. Damages, if any, to furniture or fittings and fixtures shall be recoverable from the contractor.

CURING

Curing shall be done as per plaster work with special reference to the particular type of plaster mix as described under sub-head finishing'.

FINISHING

After the plaster is thoroughly cured and dried the surface shall be white washed or colour washed to suit the existing finishing as required unless specified.

MEASUREMENTS

Length and breadth shall be measured correct to a cm. The area shall be calculated in square metre correct to two places of decimal. Patches below 0.05 square metre in area shall not be measured for payment.

Pre-measurements of the patches to be plastered shall be recorded after the old plaster has been cut and wall surface prepared.

3.03 RATE

The rate includes the cost of all the materials and labour involved in all the operations described above including lead as described in the item for disposal of old dismantled plaster /material.

END OF SECTION 17001.

10. WATER SUPPLY, SANITARY AND DRAINAGE WORKS

1.0 SCOPE

1.1 This specification covers the general requirements of providing and laying water mains and water supply piping and providing and laying drainage lines.

1.2 For specifications, mode of measurements and scope of work covered under the respective items for the work included under this contract, following documents shall be referred to in the order of precedence as given below:

(a) Description of the items and notes if any given in the Schedule of Quantities.

(b) Drawings

(c) Specifications.

(d) Additional/ Special Conditions of Contract.

(e) General Conditions of Contract.

(f) Applicable Codes and Standards as specified herein with amendments/ revisions issued till date.

In the event of any discrepancy among the documents referred above, the document in the higher order of precedence shall prevail.

1.3 In the event of any element of specification not being available in any of the documents mentioned above, the instructions of the Engineer in writing shall be followed by the Contractor.

1.4 The Work shall be carried out in accordance with the drawings and designs as would be issued to the Contractor by the Engineer duly signed and stamped by him. The Contractor shall not take cognisance of any drawings, designs, specifications, etc. not bearing Engineer's signature and stamp. Similarly the Contractor shall not take cognisance of instructions given by any other Authority except the instructions given by the Engineer in writing.

1.5 The Work shall be executed and measured as per metric dimensions given in the Schedule of Quantities, drawings, etc.

1.6 The Contractor shall acquaint himself fully with the partial provisions for supports that may be available in the structure and utilise them to the extent possible. In any case the Contractor shall provide all the supports regardless of provisions that have been already made. Nothing extra shall be payable for situations where bed plates (for supports) are not available or are not useful.

1.7 The Contractor shall incorporate seismic considerations of anchoring and isolation in the design of the systems as per the requirements of the different equipment.

1.8 Shop coats of paint that may be damaged during shipment or erection shall be cleaned off with mineral spirits, wire brushed and spot primed over the affected areas, then coated with paint to match the finish over the adjoining shop painted surface.

1.9 In addition to the sectional testing carried out during the construction, the Contractor shall test the entire installation after connections to the overhead tanks or pumping system or mains. He shall rectify all leakage and shall replace all defective materials in the system. Any consequential damage done to the building, furniture and fixtures on account of Contractor’s carelessness, like open or burst pipes or failure of fittings during testing and commissioning shall be made good by the Contractor at no additional cost.

2.0 SCAFFOLDING

2.1 Only steel tube scaffolding of approved design shall be used for all works. The scaffold structure shall comply with the requirements of IS: 4014 and IS: 3696. An

independent tied scaffold (single and double scaffold), which has two lines of standards, shall be provided with the inner line kept at least one board clear of the finished face with extended transoms, or hop up baskets to carry an inside board. Diagonal braces shall not prevent the material being moved along the scaffold run. The scaffolding shall be suitably packed at the ends to prevent damage to the finished work.

3.0 PROTECTION

3.1 Protection against damage: Care shall be taken to avoid damage from any cause at all stages. Packing pieces used for protection shall not disfigure or otherwise permanently mark the Works.

3.2 Surface protection shall be afforded by careful handling and the avoidance of the use of hooks, crowbars, or other implements that are likely to damage the works.

3.3 During installation of piping, open end of pipe shall be protected with temporary cover to prevent dust or other materials entering it.

3.4 Protection during construction: Decorative surfaces shall be carefully protected during construction by providing a temporary cover.

3.5 Protection of finished work: At all stages of the Contract it is essential that all works are properly protected.

3.6 Suitable packing shall be used to ensure that scaffolding does not damage erected stone, marble, granite or other finished works.

3.7 Any disfigurement, discolouration or imperfection whatsoever due to any reason shall not be accepted and the Contractor shall either remedy the same or redo the work at no extra cost. The decision of the Engineer as to whether any work either in whole or in part is acceptable or not shall be final and binding on the Contractor.

4.0 GUARANTEE

4.1 The Contractor shall guarantee and undertake to maintain and rectify the various components of the Plumbing work installed by him for successful performance for a period as indicated elsewhere in the tender/ contract document. The Contractor shall indemnify the Engineer for a similar period against any damage to property and injury to persons on account of any defective work or maintenance carried out by the Contractor. The format and text of the Guarantee and the Indemnity Bond shall be given by the Engineer.

5.0 APPLICABLE CODES, STANDARDS AND PUBLICATIONS

5.1 All equipment, supply, erection, testing and commissioning shall comply with the requirements of Indian Standards and code of practices given below as amended till date. All equipment and material being supplied by the Contractor shall meet the requirements of IS and other Codes/ Publications as given below.

SP: 6 (1)	Structural steel sections.
IS: 325	Three phase induction motors.
IS: 554	Dimensions for pipe threads where pressure tight joints are required on the threads
IS:694	PVC insulated cables for working voltages up to and including 1100 V.
IS: 779	Specification for water meters (domestic type).
IS: 800	Code of Practice for general construction in steel.
IS: 1068	Electroplated coatings of nickel plus chromium and copper

	plus nickel plus chromium.
IS: 1172	Code of Basic requirements for water supply drainage and sanitation.
IS: 1367 (Part 1)	Technical supply conditions for threaded steel fasteners: General Requirements.
IS: 1367 (Part 2)	Technical supply conditions for threaded steel fasteners: Tolerances for fasteners – Bolts, screws, studs and nuts – Product Grades A, B and C.
IS: 1554 (Part 1)	PVC insulated (heavy duty) electric cables: For working voltages up to and including 1100 V.
IS: 1554 (Part 2)	PVC insulated (heavy duty) electric cables: For working voltages from 3.3 kV up to and including 11 kV.
IS: 1726	Specification for cast iron man hole covers and frames.
IS: 1742	Code of practice for building drainage.
IS: 2065	Code of practice for water supply in buildings.
IS: 2104	Specification for water meter boxes (domestic type).
IS: 2373	Specification for water meters (bulk type).
IS: 2379	Colour code for identification of pipelines.
IS: 2527	Code of practice for fixing rain water gutters and down pipes for roof drainage.
IS: 2629	Recommended practice for hot dip galvanizing on iron and steel.
IS: 3114	Code of practice for laying of cast iron pipes.
IS: 4111 (Part 1)	Code of practice for ancillary structures in sewerage system: Manholes.
IS: 4127	Code of practice for laying glazed stoneware pipes.
IS: 4853	Recommended practice for radiographic inspection of fusion welded butt joints in steel pipes.
IS: 4985	Unplasticised PVC pipes for potable water supplies - specification.
IS: 5329	Code of practice for sanitary pipe work above ground for buildings.
IS: 5455	Cast iron steps for manholes.
IS: 6159	Recommended practice for design and fabrication of material prior to galvanising.
IS: 7558	Code of practice for domestic hot water installations.
IS: 8321	Glossary of terms applicable to plumbing work.
IS: 9668	Maintenance of water supplies and fire fighting.
IS: 9842	Preformed fibrous pipe insulation.
IS: 9912	Coal tar based coating materials and suitable primers for protecting iron and steel pipe lines.

IS: 10221	Code of practice for coating and wrapping of underground mild steel pipelines.
IS: 10234	Recommendations for general pipeline welding.
IS: 10446	Glossary of terms relating to water supply and sanitation.
IS: 11149	Rubber Gaskets.
IS: 11790	Code of practice for preparation of butt welding ends for pipes, valves, flanges and fittings.
IS: 12183 (Part 1)	Code of practice for plumbing in multi-storeyed buildings: Water Supply.
IS: 12251	Code of practice for drainage of building basements.
BS: 5572	Code of practice for sanitary pipe work.
BS: 6700	Specification for design, installation, testing and maintenance of services supplying water for domestic use within buildings and their curtilages.
BS: 8301	Code of practice for building drainage.
BSEN274	Sanitary tap ware, waste fittings for basins, bidets and baths. General technical specifications.
IS: 458	Specification for precast concrete pipes(with and without reinforcement).
IS:651	Salt glazed stoneware pipes and fittings.
IS: 1239 (Part 1)	Steel tubes, tubulars and other wrought steel fittings: Steel tubes.
IS: 1536	Centrifugally cast (spun) iron pressure pipes for water, gas and sewage.
IS: 1538	Cast iron fittings for pressure pipes for water, gas and sewage.
IS: 1729	Sand cast iron spigot and socket soil, waste and ventilating pipes, fitting sand accessories.
IS: 1879	Malleable cast iron pipe fittings.
IS: 1978	Line pipe.
IS: 1979	High test line pipe.
IS: 2501	Copper tubes for general engineering purposes.
IS: 2643 (Part 1)	Dimensions for pipe threads for fastening purposes: Basic profile and dimensions.
IS: 2643 (Part 2)	Dimensions for pipe threads for fastening purposes: Tolerances.
IS: 2643 (Part 3)	Dimensions for pipe threads for fastening purposes: Limits of sizes.
IS: 3468	Pipe nuts.
IS: 3589	Seamless or electrically welded steel pipes for water, gas and sewage (168.3 mm to 2032 mm outside diameter).

IS:3989	Centrifugally cast (spun) iron spigot and socket soil, waste and ventilating pipes, fittings and accessories.
IS: 4346	Specifications for washers for use with fittings for water services.
IS: 4711	Methods for sampling steel pipes, tube sand fittings.
IS: 6392	Steel pipe flanges.
IS: 6418	Cast iron and malleable cast iron flanges for general engineering purposes.
IS: 7181	Specification for horizontally cast iron double flanged pipes for water, gas and sewage.
IS: 778	Specification for copper alloy gate, globe and check valves for water works purposes.
IS: 780	Specification for sluice valves for water works purposes (50 mm to 300 mm size).
IS: 1703	Specification copper alloy float valves (horizontal plunger type) for water supply fittings.
IS: 2906	Specification for sluice valves for water works purposes (350 mm to 1200 mm size).
IS: 3950	Specification for surface boxes for sluice valves.
IS: 5312 (Part 1)	Specification for swing check type reflux (non return) valves: Single door pattern.
IS: 5312 (Part 2)	Specification for swing check type reflux (non return) valves: Multidoor pattern.
IS:12992 (Part 1)	Safety relief valves, spring loaded: Design.
IS: 13095	Butterfly valves for general purposes.
IS: 1700	Specification for drinking fountains.
IS: 2692	Specification for ferrule for water services.
IS: 5961	Specification for cast iron gratings for drainage purposes.

6.0 QUALITY ASSURANCE AND QUALITY CONTROL

6.1 The Work shall conform to high standards of design and workmanship, shall be structurally sound and aesthetically pleasing. Quality standards prescribed shall form the backbone for the Quality Assurance and Quality Control system.

6.2 At the site level the Contractor shall arrange the materials, their stacking/ storage in an appropriate manner to ensure quality. Contractor shall provide equipment and manpower to test continuously the quality of materials, assemblies, etc. as directed by the Engineer. The test shall be conducted continuously and the result of tests maintained. In addition the Contractor shall keep appropriate tools and equipment for checking alignments, levels, slopes and evenness of surface.

6.3 The Engineer shall be free to carry out tests as may be considered necessary by him at his sole discretion, from time to time, in addition to those specified in this document. The Contractor shall provide the samples and labour for collecting the samples. Nothing extra shall be payable to the Contractor for samples or for the collection of the samples.

6.4 The test shall be conducted at the site laboratory that may be established by Engineer or at any other Standard Laboratory selected by Engineer.

6.5 The Contractor shall transport the samples to the laboratory for which nothing extra shall be payable. In the event of Contractor failing to arrange transportation of the samples in proper time Engineer shall have them transported and recover at two times the actual cost from the Contractor's bills.

6.6 Testing charges shall be borne by the Contractor.

6.7 Testing may be witnessed by the Contractor or his authorised representative. Whether witnessed by the Contractor or not, the test results shall be binding on the Contractor.

7.0 SANITARY AND OTHER APPLIANCES

7.1 SCOPE OF WORK

Without restricting to the generality of the foregoing, sanitary and other appliances shall inter-alia include the following:

(a) Sanitary appliances and fixtures for toilets.

(b) Chromium plated brass fittings.

(c) Stainless steel sinks.

(d) Accessories e.g. towel rods, toilet paper holders, soap dish, liquid soap dispensers, towel rails, coat hooks, etc.

(e) Mirrors, hand driers, drinking water fountains, etc.

Whether specifically indicated or not the Contractor shall provide for all appliances and fixtures, all fixing devices, nuts, washers, teflon tape, sealant, cement, brackets, supports, paints, connectors, Chromium Plated (CP) riser pipes, adopters, bolts, screws, hangers, etc., as required.

All exposed pipes within toilets and near appliances/ fixtures shall be of CP brass or copper unless otherwise specified.

7.2 GENERAL REQUIREMENTS

7.2.1 All materials shall be new and of quality conforming to specifications and subject to the approval of the Engineer. Wherever particular makes are mentioned, the choice of selection shall remain with the Engineer.

7.2.2 All appliances, fixtures and fittings shall be provided with all such accessories as are required to complete the item in working condition whether specifically mentioned or not in the Schedule of Quantities, specifications, and drawings. Accessories shall include proper fixing arrangement, brackets, nuts, bolts, washers, screws and required connection pieces.

7.2.3 Fixing screws shall be half round head CP brass screws, with CP brass washers unless otherwise specified.

7.2.4 Porcelain sanitary ware shall be glazed vitreous china of first quality free from warps, cracks and glazing defects conforming to IS: 2556. The choice of the colour of the Sanitary ware shall be that of the Engineer and nothing extra shall be payable to the Contractor for fixing of Sanitary ware of any colour.

7.2.5 CP fittings shall be cast brass CP of the best quality approved by the Engineer.

7.2.6 If Supply of sanitary appliances, fixtures are fittings are in Owner’s scope, Contractor shall ensure that no damages occur to the same during shifting, transportation, installation and successful handing over. If any damage occurs, the same shall be replaced by the Contractor at his own cost.

7.2.7 All appliances, fittings and fixtures shall be fixed in a neat workmanlike manner true to level and to heights shown on the drawings and in accordance with the manufacturer's recommendations. Care shall be taken to fix all inlet and outlet pipes at correct positions. Faulty locations shall be made good and any damage to the finished floor, tiling, plaster, paint, insulation or terrace shall be made good by the Contractor at his own cost.

7.2.8 All materials shall be rust proofed; materials in direct or indirect contact shall be compatible to prevent electrolytic or chemical (bimetallic) corrosion.

7.2.9 Sanitary appliances, subject to the type of appliance and specific requirements, shall be fixed in accordance with the relevant standards and the following:

(a) Contractor shall, during the entire period of installation and afterwards protect the appliances by providing suitable cover or any other protection in order to absolutely prevent any damage to the appliances until satisfactory handing over. (The original protective wrapping shall be left in position for as long as possible).

(b) The appliance shall be placed in correct position or marked out in order that pipe work can be fixed or partially fixed first.

(c) The appliance shall be fixed in a manner such that it will facilitate subsequent removal, if necessary.

(d) All appliances shall be securely fixed. Manufacturers' brackets and fixing methods shall be used wherever possible. Compatible rust proofed fixings shall be used. Fixing shall be done in a manner that minimises noise transmission.

(e) Appliances shall not be bedded (e.g. WC pans and pedestal units) in thick strong mortar that could crack the unit (e.g. a ceramic unit).

(f) Pipe connections shall be made with de-mountable unions. Pipe work shall not be fixed in a manner that it supports or partially supports an appliance.

(g) Appliances shall be fixed so that water falls to the outlet (e.g. baths).

(h) All appliances shall be secured as per the recommendations of manufacturer.

(i) Appliances shall be fixed true to level firmly fixed to anchor or supports provided by the manufacturer and additional anchors or supports where necessary.

7.2.10 Sizes of Sanitary fixtures given in the Specifications or in the Schedule of Quantities are for identification with reference to the catalogues of makes considered. Dimensions of similar models of other makes may vary within +10% and the same shall be provided and no claim for extra payment shall be entertained nor shall any payment be deducted on this account.

7.3 WASH DOWN WATER CLOSET

7.3.1 WC shall be wash down or siphonic wash down type floor or wall mounted set, as shown in the drawings, designed for low volume flushing from 3-6 litres of water, flushed by means of a flushing cistern or an exposed or concealed type (as detailed in the drawings or as directed by the Engineer) 32 mm size CP brass flush valve with regulator valve. Flush pipe/ bend shall be connected to the WC by means of a suitable rubber adaptor. Wall hung WC shall be supported by CI floor mounted chair, which shall be fixed in a manner as approved by the Engineer.

7.3.2 Each WC set shall be provided with a solid plastic seat, rubber buffers and CP brass hinges. Plastic seat shall be so fixed that it remains absolutely stationary in vertical position without falling down on the WC.

7.3.3 Each WC set shall be provided with a fixed type CP brass ablution jet, if called for in Schedule of Quantities, complete with CP/ plastic piping, concealed type CP brass

angle cock, etc. all of approved make and brand. The nozzle of the ablution jet and its holding down plate shall have smooth and rounded edges and shall not be capable of causing any injury to a user or cleaner.

7.4 UNIVERSAL TYPE WATER CLOSET

7.4.1 Universal type water closet shall be wash down or siphonic type floor mounted porcelain ware flushed by means of a porcelain flushing cistern or an exposed or concealed type (as detailed in the drawings or as directed by the Engineer) 32 mm size CP brass flush valve with regulator valve. Flush pipe/ bend shall be connected to the WC by means of a suitable rubber adaptor.

7.4.2 Each WC set shall be provided with a solid plastic seat, rubber buffers and chromium plated brass hinges. Plastic seat shall be so fixed that it remains absolutely stationary in vertical position without falling down on the WC.

7.4.3 Provisions of clause7.3.3 above shall be applicable.

7.5 URINALS

7.5.1 Urinals shall be lipped type half stall white glazed vitreous china of size as called for in the Schedule of Quantities.

7.5.2 Half stall urinals shall be provided with 15 mm dia. CP spreader, 32 mm dia. CP domical waste and CP cast brass bottle/ ”P” trap with pipe and wall flange and shall be fixed to wall by CI brackets, CI wall clips and CP brass screws as recommended by manufacturer complete as directed by the Engineer.

7.5.3 Flushing for urinals shall be by means of no hand operation, PVC or ceramic flushing cistern/ electronic auto flush valve with all internal fittings, mounted on a CI brackets, and painted with two coats of approved paint of approved shade and confirming to IS: 2326.

7.5.4 Flush pipes shall be PVC pipes concealed in wall chase but with chromium plated bends at inlet and outlet or as given in Schedule of Quantities. These shall be measured and paid for separately.

7.5.5 PVC waste pipes shall be provided for urinals. Waste pipes may be exposed on wall or concealed in chase as directed by the Engineer. These shall be measured and paid for separately.

7.6 URINAL PARTITIONS

7.6.1 Urinal partitions shall be white glazed vitreous china of size specified in the Schedule of Quantities.

7.6.2 Porcelain partitions shall be fixed at proper heights with CP brass bolts, anchor fasteners and MS clips as recommended by the manufacturer and directed by the Engineer.

7.7 WASH BASIN

7.7.1 Wash basins shall be white glazed vitreous china of size, shape and type specified in the Schedule of Quantities.

7.7.2 Each basin shall be provided with painted MS angle or CI brackets and clips and the basin securely fixed to wall. Placing of basins over the brackets without secure fixing shall not be accepted. The MS angle shall be provided with two coats of red oxide primer and two coats of synthetic enamel paint of make, brand and colour as approved by the Engineer.

7.7.3 Each basin shall be provided with 32 mm dia. CP waste with overflow, pop-up waste or rubber plug, CP angle valve, CP riser pipe with connectors/ adaptors and CP brass chain as specified in the Schedule of Quantities, 32 mm dia. CP brass bottle trap with CP pipe to wall flange.

7.7.4 Wash basin shall be provided with hot and cold water mixing fitting or as specified in the Schedule of Quantities.

7.7.5 Basins shall be fixed at proper heights as shown on drawings. If height is not specified, the rim level shall be 790 mm from finished floor level or as directed by the Engineer or architect.

7.8 MIRRORS

7.10.1 Mirrors shall be electro coated, 6.0 mm thick glass of approved make, plane or beveled edge. The size shall be as specified in the Schedule of Quantities or as shown on the drawings. The image shall be clear and without waviness at all angles of vision.

7.10.2 Mirrors shall be provided with backing of 12 mm thick marine plywood, fixed with CP brass semi-round headed screws and cup washers or CP brass clamps as specified or instructed by Engineer.

7.9 TOWEL RAIL

7.13.1 Towel rail shall be chromium plated brass or of stainless steel or powder coated brass of size, shape and type specified in the Schedule of Quantities.

7.13.2 Towel rail shall be fixed with screws/capping having finish similar to the towel rail in wall with rawl plugs or nylon sleeves and shall include cutting and making good as required or directed by the Engineer.

7.10 LIQUID SOAP DISPENSER

7.14.1 Liquid Soap dispenser shall be wall/ counter mounted suitable for dispensing liquid soaps, lotions, detergents as specified in Schedule of Quantities.

7.14.2 Liquid soap dispenser shall be with CP brass bracket, caps, etc. fixed to wall with CP brass screws, and screwed onto wooden rawl plug. The container shall be of CP brass.

7.11 **HAND DRIER**

7.16.1 The hand drier shall be no touch operating type with solid state time delay to allow user to keep hand in any position.

7.16.2 The hand drier shall be fully hygienic, rated for continuous repeat use.

7.16.3 The rating of hand drier shall be such that time required to dry a pair of hands up to wrists is approximately 30 seconds.

7.16.4 The hand drier shall be of wall mounting type suitable for 230 V, single phase, 50 Hz, ac power supply.

7.16.5 The material of construction, size and finishing shall be as specified in Schedule of Quantities.

7.12 **PILLAR COCK**

A. Pillar cock shall of CP brass material table mounted type for cold water inlet of approved quality as specified in the Schedule of Quantities. Make & model shall be as per client section. Pillar Cock shall be provided with Suitable Approved type of Angle Cock.

7.13 **ROBE HOOK**

B. Robe hook shall be chromium plated brass or of stainless steel or powder coated brass of size, shape and type specified in the Schedule of Quantities.

C. Robe hook shall be fixed with screws/capping having golden finish in wall/doors with rawl plugs or nylon sleeves and shall include screwing and making good as required or directed by the Engineer-in-Charge.

7.14 **MEASUREMENT AND RATES**

D. Sanitary fixtures (Porcelain ware and CP fittings) shall be measured by numbers. Rate for providing and fixing of sanitary fixtures, accessories, shall include all items, and operations stated in the respective specifications and Schedule of Quantities and nothing extra is payable. Rates for all items under specification Clauses above shall be inclusive of cutting holes and chases and making good the same, CP brass screws, nuts, bolts and any other fixing arrangements required and recommended by manufacturers, testing and commissioning etc. complete

8.0 SOIL, WASTE, VENT & RAIN WATER PIPES

8.1 SCOPE OF WORK

Soil, waste, vent and rain water disposal scope shall include Supply, Installation, testing, commissioning and successful handing over to Owner as per the drawings, specifications and Schedule of Quantities.

All soil, waste and storm water disposal for the portion above ground level to the public sewers/STP shall be by gravity, whereas from the basement it shall be by pumping. Without restricting to the generality of the foregoing, the soil, waste, vent and rain water pipes system shall inter-alia include the following:

(a) Vertical and horizontal soil, waste, vent and rainwater pipes and fittings, joints, supports, paints and connections to fixtures.

(b) Connection of all pipes to sewer lines as shown on the drawings at ground level.

(c) Floor and urinal traps, clean out plugs, inlet fittings and rainwater (roof) outlets.

(d) Testing of all pipes and fittings in the workshop.

(e) Testing, commissioning and handing over of all pipes lines after installation.

8.2 GENERAL REQUIREMENTS

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

8.2.2 Pipes shall be fixed in a manner so as to provide easy accessibility for repair and maintenance and shall not cause obstruction in shafts, passages etc.

8.2.3 Pipes shall be securely fixed to walls and ceilings by suitable clamps at intervals specified. Only approved type of anchor fasteners shall be used for fixing pipes on RCC ceilings and RCC/ masonry walls.

8.2.4 Access doors for fittings and clean outs shall be so located that they are easily accessible for repair and maintenance.

8.2.5 Long bends shall be used on all main pipelines as far as possible. Use of elbows shall be restricted for short connections.

8.2.6 Wherever piping is going across the separation/ expansion joints of buildings, piping shall be provided with flexible connectors on both sides of such joints or on single side depending on whether any wall is to be crossed or not.

8.5.1 UPVC PIPE WORK

UPVC SWR pipe work shall be provided for above ground soil, waste, vent and rain water pipe work as shown in drawings. UPVC SWR pipes and fittings shall confirm

to IS: 13592 and IS: 14735 respectively. Pipes shall be of Type - B, pressure rating 6 kg/cm^2. The pipes shall be supplied in nominal lengths of 2, 3, 4 or 6 metres, tolerance on specified lengths shall be +10 mm and -0 mm. Any physical test requirements shall be as per IS: 13592 - 1992.

8.7.1 Handling

Because of their light weight, there may be a tendency for the UPVC pipes to be thrown often during installation. Reasonable care should be taken in handling and storage to prevent damage to the pipes. The pipes shall be stored as per manufacturer's recommendation. The Contractor shall be fully responsible in this case. In no case, pipes should be dragged on the ground. Pipes should be given adequate supports at all times.

8.7.2 Pipe Work Installation

UPVC pipes shall be laid under the flooring or hanging below slab or fixed 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 (for exposed piping) or rubber ring joint (for concealed piping). The pipes and fittings shall be capable of withstanding sun's rays. UPVC pipes laid below slab or suspended from ceiling shall be supported by GI angle brackets/ supports as detailed in the drawings.

(a) All vertical pipes shall be fixed by GI clamps truly horizontal. Branch pipes shall be connected to the stack at the same angle as that of the fittings. No collars shall be used on vertical stacks. Each stack shall be terminated at top with a vent cowl (terminal guard).

(b) Horizontal pipes running along ceiling shall be fixed on structural members by adjustable clamps of special design shown on the drawings or as directed. Horizontal pipes shall be laid to uniform slope and the clamps adjusted to the proper levels so that the pipes fully rest on them.

(c) Contractor shall provide all sleeves, openings, hangers and anchor fasteners during the construction. Sleeves shall be one size higher then pipe or there should be at least 12 mm gap all around between pipes and sleeves. Wherever pipe passes through fire rated wall, the gap shall be filled with fire rated sealant as directed by Engineer. For non-fire rated wall, gap shall be filled with wool and silicon sealant (20 mm depth). Contractor shall provide all necessary information to the building work Contractor for making such provisions in the structure as necessary. All damages shall be made good by the Contractor at his own cost to restore the surface.

(d) Door type fittings shall be used in vertical piping installations. Door position of fittings shall be on top of fitting. Easy removal of access door should be possible. The access door shall be air and water tight. Single - wye shall be used for horizontal branch connection. Double - wye fittings shall be used in vertical piping branch connection only.

8.7.3 Jointing

UPVC pipes and fittings shall be joined as per the manufacturer's instructions/ recommendations. UPVC pipes and fittings shall be joined with Solvent Cement and jointing shall be carried out as follows:

(a) Cut the spigot end of the pipe square.

(b) All burrs from the internal and external surfaces should be removed.

(c) The spigot should be marked with a pencil line at a distance equivalent to the socket depth. Clean the surface within the marked area.

(d) Apply uniform coat of approved solvent cement on the external surface to the pipe and a lighter coat on the internal surface of the fitting.

(e) Insert the pipe end into the socket of the fitting and push it in upto the mark.

(f) The pipe work should be assembled in a manner such that it does not entail making of joints in restricted area.

E. 8.7.4 Cutting and Making Good Holes/ Chases

Pipes shall be fixed and tested as the building work proceeds. Contractor shall provide all necessary holes, cut outs and chases in structural members as the building work proceeds. Wherever holes are cut or left originally, they shall be made good with cement concrete 1:1:2 (1 cement: 1coarse sand :2 stone aggregate 20 mm nominal size) or cement mortar 1:2 (1 cement :2 coarse sand) as directed by the Engineer-in-Charge and the surface restored as in original condition to the entire satisfaction of the Engineer-in-Charge at no extra cost.

8.7.5 UPVC Pipe Work Testing

UPVC pipes and fittings assembled shall be tested in accordance with IS13592 - 1992. The openings of the pipes shall be sealed for the section to be tested. The water column of 2 m shall be maintained for a maximum of 15 minutes. Contractor with his team shall examine carefully all the joints for leakage.

The Contractor shall test all vent pipes by a smoke testing machine. Smoke shall be pumped into the stack after plugging all inlets and connections and filling water in all trap seals. The test shall be conducted under a pressure of 25 mm of water and shall be maintained for 15 minutes. The stack shall then be observed for leakages and all defective pipes and fittings removed or repaired as directed by the Engineer.

A test register shall be maintained and all entries signed and dated by Contractor and Engineer. A proforma of the proposed test register shall be submitted to the Engineer for approval.

All pipes in wall chase or meant to be encased or buried shall be hydro tested before the chase is plastered or the pipe encased or buried.

All systems shall be tested in sections as required to expedite the work for other trades and meet construction schedules and final test on completion.

8.6 WASTE PIPE FROM APPLIANCES

8.7.1 Waste pipe from appliances e.g. washbasins, baths, sinks and urinals, etc. shall be of UPVC confirming IS: 4985 as given in the Schedule of Quantities.

8.7.2 The internal diameter sizes of outlet branch waste pipes for different fittings shall be as follows:

Wash Basin	32/40 dia.
Urinals	40/50 dia.
Nahani Trap	75 dia., 50 mm seal.
Multi Floor Trap	75 or 100 dia. as required, with 50 mm or 75 mm seal.

8.7.3 All pipes shall be fixed in gradient towards the outfalls of drains. Pipes inside a toilet room shall be in chase unless otherwise shown on drawings. Where required pipes may be run at ceiling level in suitable gradient and supported on structural clamps as directed by the Engineer. Spacing for the clamps shall be 3,000 mm for vertical runs and 2,400 mm for horizontal runs.

8.7.4 Pipes shall be UPVC tubes conforming to IS: 4985 and quality certificates shall be furnished. Pipes shall be provided with all required fittings conforming to IS: 4985 e.g. tees, couplings, bends, elbows, unions, reducers, nipples, plugs, etc. All UPVC

waste pipes shall be terminated at the point of connection with the appliance with an outlet of suitable diameter. Pipes shall be painted as specified.

8.7 **DRAINAGE ACCESSORIES**

(a) Floor Trap/ Urinal Trap Grating

Floor/ urinal traps grating shall be of stainless steel square/ round of size 125 mm x 125 mm square/ round as approved by Owner and shown in the drawing. Floor trap assembly shall be provided with round stainless steel strainer basket as a cockroach trap. Entire assembly shall be complete with ring, frame, outer cup, inner cup, grating, screws, etc. of an approved make.

(b) Floor Cleanout

Floor cleanout cover shall be of stainless steel square/ round of size 125 mm x 125 mm square/ round as approved by Owner and shown in the drawing. Floor cleanout assembly shall be complete with ring, outer frame, cover, screws, etc. of an approved make.

(c) Cockroach Traps

Floor/ urinal traps shall sealed cover provided with 100-150mm square or round stainless steel cockroach trap assembly complete with ring, outer cup, inner cup, jali etc. of an approved make.

8.8 **RAIN WATER OUTLET/SCUPPER DRAIN**

(a) Rain water outlet shall be preferably parapet outlets. Suitable adapter/ connector shall be used to match the pipe.

(b) Rain water outlet shall be tested for water leaking, prior to waterproofing treatment. Extreme care shall be taken, while sealing gap between rain water outlet and wall/ slab.

8.9 **MEASUREMENT AND RATES**

8.16.1 General

(a) Rates for all items shall be inclusive of all work and items called for in the specifications given above and the Schedule of Quantities as applicable for the work under floors, in shafts or at ceiling level at all heights and depths.

(b) All rates are inclusive of cutting holes and chases in RCC and masonry work and making good the same.

(c) All rates are inclusive of shop testing, pre-testing at site and final testing of the installations, materials and commissioning.

8.16.2 Pipes

(a) The unit of measurement shall be linear metre to the nearest centimetre.

(b) All UPVC/PVC soil, waste, vent, anti-siphon age and rain water pipes shall be measured net, correct to a centimetre, including all fittings along their length after fixing. The length shall be taken along centre line of the pipes and fittings. No allowance shall be made for the portions of pipe lengths entering the sockets of the adjacent pipes or fittings. The above shall apply to all cases i.e. whether pipes are fixed on wall face or pillars or embedded in masonry or pipes running at ceiling level. The quoted rate shall include lead jointing.

(c) All UPVC/PVC pipes shall be measured in running metre correct to a centimetre for the finished work which shall include fittings e.g. bends, tees, elbows, reducers, crosses, sockets, nipples, nuts, unions, etc. The length shall be taken along centre line of the pipes and fittings. All pipes and fittings

shall be classified according to their diameter, method of jointing and fixing substance, quality and finish. The diameters shall be nominal diameter of internal bore. In case of fittings of unequal bore, the largest bore shall be considered.

8.16.3 Pipe Encasing/ supports

(a) Cement concrete around pipes shall be measured along the centre of the pipe line measured per linear metre and include any masonry supports, shuttering and centering, curing, cutting, etc. complete as described in the relevant specifications.

8.16.4 GI Supports

(a) GI Supports rate for pipe work shall be included in the quoted BOQ/ SOQ rate and shall include GI channels/ angles (structural steel members), GI bolts, GI nuts, GI washers, brass screws, SS fasteners, GI threaded rod, GI clamps, GI hangers, primer coating, painting, etc. Length of supports embedded in the cement concrete blocks of 1:2:4 (1 cement : 2 coarse sand : 4 stone aggregate 20 mm nominal size) formed in the masonry walls shall not be paid extra. Also nothing shall be paid extra for the cement concrete block and making good the masonry wall, anchor fasteners, etc. complete.

8.16.5 Traps

(a) Unit of measurement shall be the number of pieces. All urinal traps, trap gratings, hoppers, clean out plugs shall be measured by number and shall include all items described in the relevant specifications and Schedule of Quantities. Cockroach traps shall not be measured separately and are deemed to be included in the rate for Traps.

8.16.6 Painting

(a) Painting of pipes shall be measured per running metre for each diameter of pipe and shall be inclusive of all fittings and clamps. No deduction shall be made for fittings.

8.16.7 Excavation for Soil Pipes

(a) No extra payment shall be admissible for excavation, dewatering, back filling, consolidation and disposal of surplus earth for soil and waste pipes.

8.16.8 Rain Water Outlet/Scupper Drain/CI KHURRA

(a) Rain water outlet shall be measured by numbers for different sizes.

(b) Leaf and gravel grates along with the perforated ring shall be measured in kilograms.

9.0 WATER SUPPLY SYSTEM

9.1 SCOPE OF WORK

The scope shall include supply, installation, testing, commissioning and satisfactory handing over of the complete water supply system to Owner as per drawings, specifications and Schedule of Quantities. The water supply system shall inter-alia include the following:

(a) Distribution system from main supply or overhead tank to all fixtures and appliances for cold and hot water.

(b) Insulation for hot water pipes.

(c) Pipe protection and painting.

(d) Control valves, masonry chambers and other appurtenances.

(e) Connections to all plumbing fixtures, tanks, appliances and municipal mains.

(f) Inserts, nozzles for Reinforced Concrete tanks.

The term water supply is used as indicative of all water supply work required and necessary for the building including such external work as may be necessary to make the system functional.

9.2 GENERAL REQUIREMENTS

9.2.1 If necessary and if approved by the Engineer, where unavoidable, bends may be formed by means of a hydraulic pipe bending machine for pipes up to 20 mm dia. No bending shall be done for pipes of 25 mm dia. and above. After bending zinc rich paint shall be applied wherever the zinc coating is damaged.

9.2.2 Valves and other appurtenances shall be so located as to provide easy accessibility for operations, maintenance and repairs. Valves shall be located at a height not exceeding 1.6 m above their operating floor/ platform level. Where such a provision is not possible and the valve is to be frequently operated a MS chain shall be provided for its operation.

9.3 CHLORINATED POLY VINYL CHLORIDE (CPVC) PIPES AND FITTINGS

CPVC pipes and fittings solvent welded type shall be used for internal cold and hot water supply piping work. CPVC pipes from 15 mm to 50 mm shall be Class - 1, SDR-11 confirming to the requirements of IS: 15778. CPVC pipes from 65 mm to 300 mm shall be Schedule 40/ Schedule 80 class confirming to the requirements of ASTM-F441 and as described in the Schedule of Quantities.

CPVC fittings i.e sockets, tees, bends, reducers, brass threaded male/ female connectors, brass threaded male/female adopters unions, bushings, etc. shall comply to the requirements of ASTM F438 and ASTM F439 for Schedule 40 and Schedule 80 class respectively. Solvent cement for CPVC pipe shall comply as per ASTM F493.

CPVC pipe work shall be installed strictly as per the recommendation of manufacturer. CPVC pipe work shall be adequately supported by GI split clamps with GI structural supports and GI threaded rods. CPVC pipe work shall be secured tightly with GI nuts, bolts and washers. Pipe work spacing shall be as per guidance of manufacturers.

After completion of piping work, piping shall be hydraulically tested in parts with test pumps at 10 bar for 24 hours or 1.5 times working pressure, whichever is higher. CPVC test plugs shall be used to seal the dead end of piping. Upon completion of entire installations, the complete system shall be tested as described above.

Upon successful testing of entire piping system, it shall be painted with one coat of approved primer and two coats of approved synthetic enamel paint, as per direction of Engineer/ Owner.

9.3.1 CPVC Piping Installation Procedure

(a) Pipe shall be cut truly straight to the required length.

(b) Remove burr (shavings) and clean the cut portion with dry cloth. Ensure that jointing portion is free from any dirt, grease or any other foreign material.

(c) Install dry fit out, by inserting pipe inside the sockets upto 1/3rd to 2/3rd penetration depth. Ensure that pipe can be inserted to the bottom of the sockets, without any resistance. If not then the process shall be repeated with another fitting.

(d) Apply a thin coat of solvent cement to the inner side of socket upto its bottom and full coat to the outer side of pipe.

(e) Insert pipe in to the socket, till the solvent is in fluid state. Twist the pipe turn to cover any dry spots.

(f) Hold the pipe for atleast 30 seconds, to ensure proper jointing. Wipe out excess solvent cement with clean dry cloth.

(g) Allow joint to cure for at least 24 hours.

(h) For pipe greater than 50 mm diameter, pipe work shall be jointed with primer and heavy duty solvent cement.

(i) Teflon tape shall be used for threaded portion of fittings.

(j) Manufacturer's recommendation shall be followed during pipe work installations.

9.3.2 Supports Spacing

CPVC pipe work supports shall be provided as per Table below:

Nominal Size (mm)	Pipe Size	Support Spacing (Metres) Respectively with Pipe Size			
		23^0C	38^0C	60^0C	80^0C
15 mm	SDR 11/ SDR 13.5	1.22/ 1.22	1.22/ 1.22	1.07/ 1.07	0.92/ 0.92
20 mm	SDR 11/ SDR 13.5	1.53/ 1.53	1.37/ 1.37	1.22/ 1.22	0.92/ 0.92
25 mm	SDR 11/ SDR 13.5	1.68/ 1.68	1.53/ 1.53	1.37/ 1.37	0.92/ 0.92
32 mm	SDR 11/ SDR 13.5	1.83/ 1.83	1.68/ 1.68	1.53/ 1.53	1.22/ 1.22
40 mm	SDR 11/ SDR 13.5	1.98/ 1.98	1.83/ 1.83	1.68/ 1.68	1.22/ 1.22
50 mm	SDR 11/ SDR 13.5	2.29/ 2.29	2.14/ 2.14	1.98/ 1.98	1.22/ 1.22
65 mm	SCH 40/ SCH 80	2.13/ 2.86	2.13/ 2.86	1.82/ 1.98	1.06/ 1.22
80 mm	SCH 40/ SCH 80	2.13/ 2.59	2.13/ 2.59	1.82/ 2.13	1.06/ 1.22
100 mm	SCH 40/ SCH 80	2.86/ 2.74	2.86/ 2.74	1.98/ 2.86	1.22/ 1.37
150 mm	SCH 40/ SCH 80	2.59/ 3.04	2.59/ 2.89	2.13/ 2.59	1.37/ 1.52

10 VALVES & FITTINGS

All valves (gate, globe, check, safety) shall be of gun metal suitable for the particular service as specified. All valves shall be of the particular duty and design as specified. Valves shall either be of screwed type or flanged type, as

specified, with suitable flanges and non-corrosive bolts and gaskets. Tail pieces as required shall be supplied along with valves. Gate, globe and check valves shall conform to Indian Standard IS: 776 and non-return valves and swing check type reflux to IS: 5312.

Sluice valves, where specified shall be flanged sluice valves of cast iron body. The spindle, valve seat and wedge nuts shall be gunmetal. They shall generally have non-rising spindle and shall be of the particular duty and design as specified. The valves shall be supplied with suitable flanges, non-corrosive bolts and asbestos fibre gaskets. Sluice valves shall conform to Indian standard IS: 780 and IS: 2906.

Ball valves with floats to be fixed in storage tanks shall consist of cast brass lever arm having copper balls (26 SWG) screwed to the arm integrally. The copper ball shall have bronze welded seams. The closing/opening mechanism incorporating the piston and cylinder shall be non-corrosive metal and include washers. The size and construction of ball valves and float shall be suitable for desired working pressure operating the supply system. Where called for forged brass valves shall be supplied with brass hexagonal back nuts to secure them to the tanks and a socket to connect to supply pipe.

Sl.no	Type of Valve	Size	Construction	Ends
a.	Isolating Valve.	15 mm to 50 mm 65 mm and above	Gun Metal	Screwed Flanged
b.	Sluice Valve & Butterfly Valve	65 mm and above	Cast Iron	Flanged
c.	GM non return valve	15 mm to 50 mm 65 mm above	Gun Metal	Screwed Flanged
d.	Flap Type – Non return valve	65 mm and above	Cast Iron	Flanged

10.1 Gunmetal Valves

A. Valves 65 mm dia. and below shall be heavy gunmetal full way valves or globe valves conforming to Class I of IS: 778. Valves shall be tested at manufacturer's works and the same stamped on it.

B. All valves shall be approved by the Engineer-in-Charge before they are allowed to be used in the Work.

10.2 Sluice Valves

A. Unless otherwise specified all valves 80 mm dia. and above shall be CI double flanged sluice valves with non rising spindle. Sluice valves shall be provided with wheel when they are in exposed positions and with a cap top when they are located underground. Contractor shall provide suitable operating keys for sluice valves with cap tops.

B. Sluice valves shall be of approved makes conforming to IS: 780 of Class as specified.

10.3 Butterfly Valves

A. Where specified, Valves 80 mm dia. and above shall be cast iron butterfly valve to be used for isolation and/ or flow regulation as directed by the Engineer. The valves shall be tight shutoff/ regulatory type with resilient seat suitable for flow in either direction and seal in both directions.

B. Butterfly valve shall conform to IS: 13095.

10.4 Non Return Valve

Where specified non return valve (swing check type) shall be provided through which flow can occur in one direction only. It shall be single door swing check type of best quality conforming to IS: 5312.

10.5 Forged Brass Ball Valve

Valves of size 50 mm dia. and below shall be full bore quarter turn lever operated female threaded forged brass hard chrome plated ball valves conforming to IS: 554. Valve shall have PTFE body seat rings and gland packing, forged brass ball, stem and bonnet, carbon steel nut washer and lever and finished in chrome. Valves shall have minimum working pressure of 20 bar. Valves shall be tested at manufacturer's works and the same stamped on it.

10.6 Ball Type Non Return Valve (NRV)

Ball type NRV shall be used in water treatment plants and sewage sump pump piping. NRV shall be constructed in cast iron body with epoxy coating, phenolic resin and NBR (Nitrile) seal. NRV shall have flanged ends and can be installed in horizontal as well as vertical position. NRV shall have minimum working pressure of 20 bar or as per system requirements. Valves shall be tested at manufacturer's works and the same stamped on it.

10.7 Air Release Valve (ARV)

A. Pressurized water supply lines shall be provided with air release valve at highest point to release accumulated air for piping system. Air release valve shall be automatic float operated, the diameter shall be as specified in the Schedule of Quantities. Air release valve shall be provided with ball valve for ease in Operation and Maintenance. Valve body shall be in cast iron stainless steel, brass and EPDM internal components. Valves shall have minimum working pressure of 20Kgs.

B. Air release valve shall be installed as per specifications provided in BOQ.

C. Table Commonly Adopted Size of Air Valves

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

E. Each air release valve shall be provided with a cast iron isolating sluice valve of specification given above.

11.0 TESTING

(a) All pipes, fittings and valves shall be tested in accordance with IS: 2065 except as may be modified herein under. All pipes, fittings and valves, after fixing at site, shall be tested to a hydrostatic pressure of 20 kg/cm2 or 1.5 times the shut off head of the pump whichever is greater.

(b) The test pressure shall be maintained for a period of at least thirty minutes without any drop in pressure.

(c) A test register shall be maintained and all entries shall be signed and dated by Contractor(s) and the Engineer-in-Charge.

(d) After commissioning of the water supply system, the Contractor shall test each valve by closing and opening it a number of times to observe if it is working

efficiently and effectively. Valves which do not operate efficiently and effectively shall be replaced by new ones at no extra cost and the same shall be tested as above.

(e) All pipes in wall chase or meant to be encased or buried shall be hydro tested before the chase is plastered or the pipe encased or buried.

12.0 DISINFECTION OF INSTALLATION

The water supply installation shall be disinfected as per standards and as follows:

a) Tanks and pipes shall be filled and flushed out.

b) All bib cocks (taps) shall be closed.

c) Tanks and pipes shall be re-filled while adding sterilizing admixture containing 50 parts chlorine to one million parts water.

d) When the installation is filled all bib cocks (taps) shall be opened progressively and each allowed running until the water smells of chlorine.

e) The installation shall be topped up and more sterilizer added.

f) The installation shall then be left for three hours and shall then be tested for residual chlorine; if none is found, the installation shall be drained and the process repeated.

g) The installation shall be finally drained and flushed with potable water before use.

13.0 DISINFECTION OF PIPING SYSTEM AND STORAGE TANKS

Before commissioning the water supply system, the contractor shall arrange to disinfect the entire system as described in the succeeding paragraph.

The water storage tanks and pipes shall first be filled with water and thoroughly flushed out. The storage tanks shall then be filled with water again and disinfecting chemical containing chlorine added gradually while tanks are being filled to ensure thorough mixing. Sufficient chemical shall be used to give water a dose of 50 parts of chlorine to one million parts of water.

If ordinary bleaching powder is used, the proportions will be 150 gm of power to 1000 litres of water. The power shall be mixed with water in the storage tank. If a proprietary brand of chemical is used, the proportions shall be specified by the manufacturer. When the storage tanks are full, the supply shall be stopped and all the taps on the distributing pipes are opened successively working progressively away from the storage tank. Each tap shall be closed when the water discharged begins to smell of chlorine. The storage tank shall then be filled up with water from supply pipe and added with more disinfecting chemical in the recommended proportions. The storage tank and pipe shall then remain charged at least for three hours. Finally the tank and pipes shall be thoroughly flushed out before any water is used for domestic purpose.

The pipe work shall be thoroughly flushed before supply is restored.

14.0 COMMISSIONING

(a) Release water in the lines by opening Valves in the circuit. Drain out water in the system through scour valves in lower regions. Ensure clean water is now coming out of the system.

(b) Check all outlet points for proper operation by opening each valve and allowing water to flow for a few minutes. Also check for effective closure of valve.
(c) The entire water supply system should be disinfected with bleaching powder and system flush cleaned.

15.0 MEASUREMENT AND RATES

15.1 CPVC Pipes

(a) CPVC pipes above ground shall be measured per linear metre (to the nearest cm) along the centre line of the pipe and shall be inclusive of all fittings e.g. couplings, tees, bends, elbows, unions, flanges, etc. Deduction for valves shall be made. Rates quoted shall be inclusive of all fittings, clamps, cutting holes chases and making good the same and all other items mentioned in the specifications and Schedule of Quantities.

15.2 Valves

Valves shall be measured by numbers.

15.3 Flanges for Nozzles

(a) Flanges for nozzles shall be measured by numbers and the quoted rate shall include welding of the flanges to the pipe nozzles.

(b) Painting/ Pipe Protection/ Insulation

Unless otherwise specified painting/ pipe protection/ insulation for pipes shall be measured and paid for separately. These shall be measured per linear metre along the centre line of the pipe, over the finished surface and shall include all valves and fittings for which no deduction shall be made.

16.0 PROVIDING ACCESSORIES

Contractor shall provide following accessories. The cost related with these items shall be included in relevant plumbing works

a) 4 nos. (2 each in IPS building and Sub-office) of ABS Rinsing spray with regulator of approved quality with plastic flexible pipe 1.5 m long, wall hook complete as required.

b) 4 nos. (2 each in IPS building and Sub-office) of C.P. brass eurometic self closing pillar tap for Wash basin with all accessories complete.

c) 4 nos. (2 each in IPS building and Sub-office) of Auto Air vent for cold water supply risers – 15 mm

d) 2 nos. (1 each in IPS building and Sub-office) of uPVC Multi Floor Trap with 50 mm water seal conforming to IS:14735-90

END OF SECTION.

MECHANICAL TECHNICAL SPECIFICATIONS

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1 DRY PIT SUBMERSIBLE CENTRIFUGAL PUMP:

1.1 Existing pump parameters:

The Operating Parameters of the existing Pump sets are as follows:

Type: End Suction Side Discharge vertically mounted Sewage pumps coupled to TEFC motor installed at the height of about 4.5 meters from pump floor.

Flow	:	138.24 MLD
Head	:	25.3 meters
Motor kW	:	535 kW, 6.6kV
Speed	:	590 rpm
No. of pumps	:	5 Nos. (4 working and 1 standby)

1.2 Scope of Works:

The Existing 5 pumps (4 working and 1 standby) shall be replaced with 6 pumps (5 working and 1 standby) of 139.8 MLD each at 36 meters head. As the existing pump foundations are designed for 5 pumps, the proposed 6 pumps shall be accommodated in existing space with necessary modifications in pump foundation to suit the new pumps and the submersible motors which shall be directly coupled to the pumps without need for long transmission shaft. The existing six suction lines shall be connected to the proposed 6 pumps and existing 5 delivery lines shall be increased to 6 delivery lines as per pump delivery.

All modifications in the existing pump set foundation to allow for erection and maintenance of the proposed pump set shall be carried out by the contractor.

The pump manufacturer shall have manufactured, supplied and commissioned minimum 2 nos of pumps having minimum 300 KW HT pump in one sewage/water pumping station or in one sewage/water lifting pump house in STP. (Purchase order copies and Client taking over certificates shall be submitted along with bid for substantiation of the same) and;

I. The pumps shall be in successful operation since last minimum five years and shall be in operation. (Certificate from concern authority shall be submitted by Tenderer with bid in packet B)
II. The manufacturer shall be in manufacturing of pumps since minimum last 10 year (Certificate shall be submitted by Tenderer with bid in packet B).
III. The Manufacturer shall possess ISO-9001 Quality Management System certification and shall possess Occupational Health and Safety Assessment Series, (officially BS OHSAS 18001) (Certificate shall be submitted by Tenderer with bid in packet B).

The Pump should be working satisfactorily. BMC has all rights to visit the site of installation for verification.

1.3 Proposed pumping station:

1.3.1 General:

A. The pump house shall be modified for installing six pumps with 5 working and 1 standby.
B. Provide all pumps, accessories, monitoring requirements from a single supplier who shall be responsible for all equipment of this section.
C. Provide submersible solids-handling pumps, as specified here and having operating characteristics as specified in the data sheet.

1.3.2 Criterial for selection of Raw Sewage pumps:

A. The pump to have a continuously rising characteristic curve from the rating point to the shut off point.
B. Mark operating range on single pump performance curves.
C. The difference between and NPSH Available (NPSHa)and NPSH Required (NPSHr) at duty point shall not be less than 1m.
D. The critical speed shall be well away than operating speed and in no case less than 130% of rated speed.
E. The rating of the Pump Driver shall be greater of the following
   - Minimum 15% over the brake kW at above duty point at speed corresponding to 50 Hz.
   - 5% over the maximum kW absorbed by the pump for single pump.

1.3.3 Raw Sewage Pumps:

A. Each pump unit shall be of vertical, submersible, dry pit installation for pumping typical municipal sewage, bottom suction non-clog centrifugal type having its impeller directly mounted on the extended motor shaft. The pump with its appurtenances and cable etc. shall be capable of continuous operation while submerged at 30 m depth without damage to pump seals or motor.
B. Pumps shall be supplied with a vertical bottom inlet and a horizontal discharge.
C. Pump casing/volute with discharge connection shall be of grey cast iron, construction, ASTM A-48 Class 35B, with anti corrosive, anti abrasive lining, smooth finish and with stainless steel fasteners.
D. Pump impeller shall be duplex stainless steel as specified in datasheet, dynamically balanced, semi-open/enclosed impeller non-clog design. The pump impeller shall be casted. Fabricated impeller is not acceptable. The impeller shall be capable of handling solids up to 100 mm size and other matter found in wastewater. The impeller shall be firmly connected and locked to the motor shaft. The impeller shall be dynamically balanced to ISO-10816 standards for smooth vibration-free operation.
E. The pump shaft shall be an extension of the motor shaft and shall be AISI 431 stainless steel. Adequately design the shaft to meet the maximum torque required at the startup or at any operating point through the pumping range. Shaft couplings are not acceptable.
F. Wear plate of cast iron mounted on volute with adjustment screws shall provide close tolerance with the impeller.

G. Mechanical seals shall be a tandem system consisting of two totally independent seal assemblies. The shaft seal shall be located in lubricant chamber, with silicon carbide/silicon carbide or tungsten carbide/tungsten carbide inner and outer seals. The lubricant chamber shall have easily accessible drain and filling plugs. The lubricant shall automatically cool the motor body and the bearings.
H. Pump bearings shall be lubricated for life, shall have life of minimum 50,000 runhours and be designed and spaced to transfer all radial and axial loads to the pump housing and to minimize shaft deflection.

1.3.4 HT motors:

A. Pump motor shall be housed in a watertight air filled cast-iron casing directly connected to the top of the pump casing/volute with IP68 protection. The motor casing of ASTM A-48 Class 35B. The motor shall be specifically insulated to offer high resistance to moisture, heat and wear. Provide necessary lifting eye lugs on the top of the casing.
B. Provide High efficiency motors rated at 6.6 kV, 3-phase, 50 Hz supply, 1.1 service factor, S1 duty type, Class H insulation, waterproof cable entry with B Class temp rise.
C. Motor shall be of squirrel cage induction shell type design, housed in an air-filled submersible watertight chamber.
D. The motor shall be VFD compatible and be designed for continuous duty, capable of sustaining at least six starts per hour. The motor shall be non-overloading throughout the entire pump range of operation without utilizing the motor service factor.
E. Cool the motor and moving parts through the use of the surrounding liquid sewage or an integral closed loop liquid recirculation system (using a non-toxic glycol) as required to suit the pump size. Vertical fins on the exterior of the motor casing are acceptable.
F. Provide sensors to monitor temperature of both upper and lower bearings in the motor. This shall report data to the remote monitoring/supervisory panel.
G. Provide thermal switches embedded in the stator to monitor the temperature of each phase winding. This shall report data to remote monitoring/supervisory panel.
H. Provide leakage sensor to detect moisture in the sensing chamber between oil and stator chambers. When activated the moisture sensor system shall report data to remote monitoring/supervisory panel.
I. Provide vibration sensors to detect abnormal pump movement. This shall report data to the remote monitoring/supervisory panel.
J. Provide anti-rotation monitoring to detect reverse rotation of the shaft/motor while the pump is stopped. The system shall not allow the pump to restart until the reverse rotation situation has stopped. This shall report data to the remote monitoring/supervisory panel.

1.3.5 Electrical Cables:

A. Provide suitable length of power cable from each pump motor up to respective 6.6kV 3-phase 50 Hz electric switchgear panel. Provide suitable length of 415V 3-phase 50 Hz multi core type monitoring cable (for the various detection sensors) with two spare cores for each pump set. The cables shall conform to IEC 245 (IS 9968 Part I) standards of

polychloroprene rubber with easy flexing capabilities. All conductors shall be identified and labelled for the connection requirements.

B. Cable sealing is to be accomplished by the use of a wedge shaped rubber grommet surrounding each cable with a stainless steel follower washer and tightening bolts.
C. Cables shall be capable of continuous submergence under water without loss of water tight integrity to a minimum depth of 30 metres. All cables shall be continuous to the junction boxes outside of the wet well.

1.3.6 Remote Monitoring/ Supervisory Panels:

A. Provide each pump with its own remote monitoring/supervisory panel specifically designed for analysis, monitoring and displaying all the sensing signals from the pump and act as a supervisory system.
B. The design shall also include for stopping the pump as necessary, send alarm/warning signals to a remote control system and a reset button. Provide each panel with a minimum two sets of relay contacts, one set interlocked for stopping the pump and the other set as spare. Each panel to be suitable for outdoor wet weather, padlock-able and wall mountable.

1.3.7 Fasteners:

A. All fasteners, bolts, nuts, washers, screws, anchors etc shall be of 316 stainless steel.

1.3.8 Protective Coating:

A. All external surfaces of the assembled pump units, internal wetted surfaces of the casing/impellers shall be provided as per the pump manufacturer's standard factory specifications applied with anti corrosive and anti abrasive coating.

1.3.9 Factory Testing:

A. The combined pump and motor units shall be tested in the manufacturer's factory in accordance with the standards of the ISO 9906 Gr. 1B/Hydraulic Institute. The manufacturer shall have in house HT motor testing facility.
B. The minimum extent of testing shall be as follows:
    - Certified performance tested in accordance with the standards of the Hydraulic Institute in the factory of the manufacturer.
    - The pump casing shall be hydrostatically pressure tested to 1.5 times of maximum allowable pressure. Maximum discharge head is defined as the sum of the shut-off head and maximum suction head. Unless otherwise stated in data sheet A, the hydrostatic tests on the casing shall be conducted for a minimum duration of 10 minutes.
    - The negative Tolerance on Efficiency shall be limited to 3%. The Pumps shall be tested over the range covering from Shut Off Head to Maximum Flow.

1.3.10 Shipping:

A. Submit the certified test pump curves before shipping the pumps. Do not ship the pumps until the certified pump curves have been accepted.

1.3.11 Installation:

A. Install pumps and other accessories as per manufacturer's instructions and in the presence of a qualified representative. Ensure the pumps, when installed, shall operate efficiently.

1.3.12 Inspection and Field Testing:

A. Provide the services of an authorized factory trained technical representative to:
   - Certify completeness of installation.
   - Certify pump performance throughout the specified head-capacity range.
   - Provide training sessions for the operation staff.
   - Minimum days of on-site factory trained technical support: 15 days per pump station (or more as required).

B. Upon successful completion of the field tests, the supplier shall submit to the BMC, a report presenting findings of the inspection, testing and any adjustments made.

1.4 Levelling, Grouting and Erection of Machinery (for Dry-pit Submersible pumps):

A. It is desirable to utilize the existing pump foundation while carrying out upgradation of the pumping station so that major outage is not required in operating the pumping station and also interference with the operation functions.
   Before undertaking the erection of pumps, the Contractor shall ensure that the levels and centers of foundation are as per approved drawings and within permissible tolerances. Contractor shall check and record the levels of foundation as existing in the prescribed formats.

B. If the base plates are to be erected on metal packers/spacers/liners, (hereinafter referred to as packers) such packers shall be machined parallel on top and bottom faces, to a smooth finish. They shall be of adequate size & numbers to support the sole plate for uniform load distribution on all sides. Packers shall be positioned on either side of hold down when they are secured against packers.

C. The packers shall preferably be rested directly on the finely dressed concrete surface of foundation, ensuring a contact area of at least 60%when checked with machinist's blue. Such dressing may be done using pen chisels, pencil grinders & abrasive blocks. Alternately, if the Contractor plans to erect the packers, on wet grout, as a means of leveling them, a minimum grout thickness of 25 mm shall be maintained beneath the packers. A recess of at least 30 mm depth with a clearance of at least 30 mm all around the packers shall be made on foundation for each of the packers. Alternately if the Contractor chooses to set the packers in epoxy mortar, the underside of packers shall be serrated or fluted for better bonding. Grades of Epoxy mortar shall be subject to approval by Engineer. The grouting of packers shall be done with form work using a non

shrinkable grout. The packers shall be placed on the wet grout sufficiently covered in grout on all sides with the elevations and levels duly adjusted and allowed to be set with the form work.

D. The packers, fixed by any means described as above, shall be leveled within 0.02 mm/metre horizontally and the top elevations shall be within ± 1 mm accuracy; minor variations in the elevations within the accuracy as specified may be made up using stainless steel shims. Any scraping to achieve the levels & elevation, if required by Contractor will be permitted. Any subsequent erection work on packers shall be undertaken only after adequate curing of grouts to achieve the required strength with due check and recording of levels and elevations.

E. If the Contractor chooses to erect the base plate entirely on jack screws and/or taper wedges, and intends removing such leveling means, after grout is set, such jack screws or taper wedges shall be of bearing plates of at least 12 mm thickness and of adequate size squarely rested on duly dressed up foundation. The taper wedges shall be machined smooth and shall be suitable for small accurate adjustments in level. The jack screws shall be adequately sized and fine threaded and suitable counter sinking shall be provided on bearing plates to prevent travel of the jack screws under load. Such taper wedges and jack screws shall be coated with paraffin wax, for easy withdrawal after grout is set.

F. If the taper wedges are intended to be left inside the grout, a pair of taper wedges, with accurately machined matching tapers shall be used, in order that, when the taper surfaces of wedges are sliding against each other the top square face of the wedge shall be within the same horizontality, as that of the base plate, and shall be squarely in contact with the under side of base plate. Such 'left in grout' wedges shall be of, packers/liners set on concrete. The taper wedges shall be adequately stitch welded together, after leveling operations are over, with the anchor bolts duly tightened and level finally checked. Irrespective of method of erection, a grout space of minimum 30 mm shall be maintained beneath the base plate.

G. The base plates shall be erected within 0.05 mm/m horizontality checked with precision levels in all directions while the target should be 0.02 mm/metre horizontally, after securing them with the anchor/hold down bolts.

H. Before proceeding with grouting, it shall be ensured that foundation concrete and packets are free from any contamination of oil, grease, weak surface materials such as laitance and dust which must all be removed by chipping, wire brushing & compressed air blasting, etc. as required. The entire concrete surface receiving the grout shall be adequately roughened. The foundation & pockets must be adequately wetted, preferably upto 8-12 hours, earlier – suitable form work shall be made by Contractor using adequately thick plywood coated with a release agent & suitably secured to the foundation on all sides. The grouting shall be carried out using non-shrinking cementitious grout materials in one continuous pouring operation, until grout has reached its eventual level ensuring that grout flows continuously until all cavities under the base plate are filled, with no air pockets, and all air from confined spaces is duly expelled. Suitable means for movement of grout shall be employed and use of vibrators shall not be permitted. All grouting methods shall be approved by the Engineer's representative and shall be carried out in his presence.

I. It shall be the Contractor's responsibility to check and maintain the levels and centers throughout the process of grouting. The foundation/anchor bolts shall be pulled up hard and the alignments and levels rechecked after the grout has set.

J. The base plate top surface in contact with the underside of pump base is to be blue matched to get a contact area of at least 80%. No shimming shall be permitted between base plate and base pump. Contractor shall carry out such blue matching after grouting operations are over, and grout is fully set and gained strength adequately. Such blue matching may be carried out before grouting operations if the Contractor so desires. However, the Contractor shall ensure that contact accuracies are maintained during leveling & grouting operations. All blue matching shall be demonstrated before erection of base plate.

K. The pump shall be placed directly on the base plate and the levels shall be checked to be within 0.05 mm/m accuracy while target shall be 0.02 mm/metre horizontality.

L. Before proceeding with the erection of pump, all sub components, all mating accuracies shall be checked and recorded in the prescribed formats, for future use. Such checks shall include but not limited to TIR of shaft, bearings, couplings, etc. as required by Engineer's Representative. The Contractor shall provide recommended value of various clearances at various mating surfaces prior to erection for approval.

M. All fasteners shall be tightened using torque wrenches to Contractor's prescribed torque values. Total indicated run outs (TIR) of shaft shall be checked to be within prescribed limits, as stipulated elsewhere in the Contract, or as prescribed by manufacturer whichever is low.

N. The Contractor shall submit the step-by-step procedure in his erection manual, with illustrated sketches, with due description of all checks, the tolerances, the clearances, before start of erection for reference & record. Irrespective of erection procedures, adopted and recommended by the Contractor, the limits, tolerances shall be in conformity with Specification, workmanship and checks. Contractor shall have additional checks together with tolerances as necessary. The Engineer's Representative may specify any additional checks not specified herein that he might find essential to satisfy himself of the correctness of erection. All the stage wise checks, inspection of installation as outlined in the specifications and /or as required by Engineer's Representative, shall be carried out by the Contractor and all observations shall be recorded by the Contractor in prescribed formats and duly countersigned by Engineer's Representative for approval.

O. The Engineer's Representative shall be informed at all times of the progress of the work and when any checks on alignment, and level, or as prescribed in specification are to be carried out, so that he may witness the checks if he so requires. The approval of the Engineer's Representative or his intimation that the alignments or levels of machines, or any other checks are to his satisfaction shall in no way relieve the Contractor of his obligation under the Contract for proper installation and alignment of machines and connected pipe work.

The Contractor shall be responsible for all Works carried out by him, and all procedures adopted by him. Any check or waiver of any check, shall not prejudice the Engineer's rights to order rectification of any installation work later found to be improperly carried out.

Details of grouting of suction and discharge pipes is to be submitted to Engineer's Representative at Site and to be executed to his full satisfaction.

2 ELECTRICALLY OPERATED TRAVELLING CRANE

2.1 Scope of Works:

The existing 20 Tons and 7.5 Tons EOT Crane in the pump house shall be replaced by proposed 20 Tons and 7.5 Tons EOT Crane in this contract.

The crane shall be mounted on the existing rail provided for travelling of crane. The condition of existing rails shall be assessed & replaced wherever required. The actual span and required side clearances shall be verified at site before submitting drawings.

2.2 General:

The crane shall be electrically operated, double girder bridge type complete with all accessories including down shop conductor, crane rails and fixtures, and shall conform to IS: 3177/ BS 466 Medium Duty. The EOT shall be complete with 4 motors (One for Hoist, one for Cross Travel and two for Long Travel) and shall be 3 Phase, AC, Sq. Cage Induction type motor.

Design duties and constraints are as follows:

	Crane 1	**Crane 2**
Safe working load (SWL)	20 MT	7.5 MT
Class	2	2
Nominal Span (m)	9.975	4.625
Maximum Lift (m)	32	32
Hoist speed	About 3.0 – 5.0 m/ min.	About 3.0 – 5.0 m/ min.
Cross Travel Speed	10.0 – 15.0 m/min	10.0 – 15.0 m/min
Long Travel Speed	10.0 - 20 m/min	10.0 - 20 m/min
All 3 motions (hoist, longitudinal and lateral travels)	Through VFD	Through VFD

Crane by travel motor shall be achieved by single motor configuration. The safe working load (SWL) specified shall be verified by bidder to suit equipment supplied by him. A capacity plate showing name of manufacturer, year of manufacture and rated capacity of hoist in figures not less than 150 mm height shall be placed on each side of the crane girder.

2.3 Crane Bridge:

The crane bridge shall consist of double bridge girder on which a wheeled trolley is to run.

The bridge trucks and trolley frames shall be fabricated from structural steel of tested quality conforming IS: 2062 Grade A or BS 2573. The bridge shall be designed to carry safely the loads specified in IS: 807. All anti-friction bearings for bridge and trolley track wheels, gear boxes and bottom sheaves on hook shall be lubricated manually by hand operated grease pump through respective grease nipples.

The maximum deflection under full load shall not exceed 1/900 of the span as per IS: 807.

2.4 End Carriages;

Wheel base and structural frame of the wheel mounting of the end carriages shall be designed so as to ensure that the crane remains square and prevent skewness. Bridge and trolley track wheels shall be of forged steel and shall be double flanged type. The wheel diameter and rail sizes shall be suitable for the wheel loads. The crane rails shall be manufactured from wear resistant steel and shall be suitably anchored on the corbel beam for full rigidity. Mountings of the wheels shall be designed to facilitate easy removal for maintenance. Steel rail stops to prevent rails from creeping and trolley from running off the bridge shall be abutted against ends of rails and welded to the girders. Bridge and trolley stops to match the wheel radius shall be provided before the buffer stops.

All exposed couplings, shafts, gear, wheels, pinions and chain drives etc. shall be safely encased and guarded completely to prevent any hazard to persons working around. All bearings and gears shall have a design life of at least 20,000 hours. Automatic Electrohydraulic Thrust (shoe) brake system shall be provided for the main hoist. One DC Disc brake shall be provided for each of the cross travel and long travel motions.

2.5 Hook:

Hook shall be solid forged, heat treated alloy or carbon steel suitable for the duty service.

They shall have swivels and operate on ball thrust bearings with hardened races and protective skirt to enclose the bearing. The lifting hook shall comply with the requirements of IS 8610 and shall have a safety latch to prevent rope coming off the hook.

Hoist rope shall be extra flexible, improved plough galvanized steel rope with well lubricated hemp core. The rope shall have a 6:1 safety factor on the specified safe working load and shall conform to IS: 2266. Rope drums shall be grooved and shall be either cast iron or cast steel or welded steel conforming to IS: 3177.

Gears shall be cut from solid cast or forged steel blanks or shall be stress relieved welded steel construction. Pinions shall be of forged carbon or heat treated alloy steel.

Strength, quality of steel, heat treatment, face, pitch of teeth and design shall conform to IS: 2535 and IS: 4460.

2.6 Electrical Equipment

The electrical equipment shall be VFD compatible. The motor specifications shall be as per specifications of Electric Motor (LT) in Electrical specifications.

All accessory and auxiliary electrical equipment including drive motors, electrically operated brakes, controllers, resistors, conductors, insulators, current collectors, pendant push button station, protective devices, operating devices, cables, conduits, etc. necessary for the safe and satisfactory operation of the crane shall be provided.

Power to the crane shall be provided by down shop conductors manufactured from high conductivity hard drawn copper. Conductors shall be completely shrouded such that they have no exposed current carrying surfaces. Pendant type push button station shall be sheet steel enclosed and shall comprise the following push buttons and indicating lamps:

'Start' and 'Stop'.

Long travel – 'Right' and 'Left'. Cross travel - 'To' and 'Fro'. Hook – 'Hoist' and 'Lower'.

Red indicating lamp for supply 'ON' indication.

Switch shall be provided for Macro & Micro Speed. Pendant type push button shall be supported independently of the electrical cable and shall be earthed separately, independent of the suspension and shall be 1.5 m above pump floor level.

Automatic reset type of limit switches shall be provided to prevent over travel for each of the following:

For 'Up' and 'Down' motions of the hook, Long travel motion, Cross travel motion.

Crane structures, motor frames and metal cases of all electrical equipment including metal conduit and cable guards shall be earthed. All motors, brakes, limit switches, panels, drum controllers, resistor unit sets shall be provided with two studs for earthing.

2.7 Testing:

The crane shall be tested for full load and 25% overload on hoisting and cross traverse motion at factory. Proper clearance, smooth rolling of wheels etc. and soundness of fabrication and welding shall also be checked.

The following tests shall be carried out at site before commissioning of crane as per IS 3177:

a) Insulation Tests
b) Operational Tests
c) Deflectional Tests
d) Overload Tests

The crane should comply with relevant safety regulations under the Factory Act and Indian Electricity Rules and other statutory regulations as applicable.

Handling tackles/slings, etc. Suitable lifting beams (as may be required), slings, etc., shall be supplied having rated capacities equal to or greater than the weight of the heaviest assembly required to be lifted during erection and maintenance. Safe working loads shall be marked on the

lifting beams, slings, etc. An Anti-collision device shall be supplied & installed for this & existing crane.

3 KNIFE GATE VALVE WITH ELECTRIC ACTUATOR:

3.1 Scope of Works:

A. Dismantling the six numbers of existing Knife gate valves at 1200 mm Suction line and Supply, installation, testing and commissioning of Knife Gate Valve with electric actuator at suction line of each pump (total 6 nos.), dismantling the five numbers of existing plug valves at 900 mm delivery line and supply, installation, testing and commissioning of 1000mm Knife Gate Valve with electric actuator at delivery line of each pump (total 6 nos). Supply, installation, testing and commissioning of 5 nos. 1800mm Knife Gate Valve with electric actuator on existing and proposed line as per shown in P&ID.
B. The Drawings, Datasheets and Specifications are intended to set the acceptable minimum standard. Ensure that the installed valves are trouble-free and meet their intended performance.

3.2 General:

3.2.1 Design Requirements:

A. Valves will be suitable for use with effluent and other processes as require. The contractor shall provide the test certificate confirming that the Valves are Tested in accordance with the standards mentioned in this specification.
B. Valves of the same type and size and designed for the same service shall be recommended to obtained from a single manufacturer and shall be interchangeable.
C. All valves shall be designed, manufactured and tested in accordance with the standards specified. Where necessary operating platforms shall be provided.
D. Unless otherwise specified, all valves, including actuated valves, shall be appropriately geared to facilitate manual operation by one person. Valves shall close by clockwise rotation and this shall be indicated on the hand-wheel.
E. Valves shall be bubble tight at rated pressures and shall perform in applications involving operation after long periods of inactivity, regardless of valve size.
F. The valves shall be suitable for frequent operation and for installation in potable water service and sewage lines.
G. Supply all valves and operators as shown or inferred in the Contract Drawings or Specifications and as required to provide a functional and safe piping system.
H. For a particular valve type, the same supplier, model and design shall be maintained throughout the project.

3.2.2 Codes and Standards:

A. Valves shall be generally as per below mentioned Standards

AWWA C520-14 / : Design and Testing Standard for Knife Edge Gate Valves

MSS - SP – 81

B. Where provisions of the pertinent codes and standards conflict with these Specifications and Drawings or with each other, comply with the more stringent provisions.
C. Use the latest issue of Standards.

3.3 Products:

3.3.1 Specifications:

A. Valve: Bi-directional pressure rated sandwich type: As per AWWA C 520 Flanged as per BS EN 1092, PN 6, PN 10.
B. Service Temperature Municipal Sewage: 20° – 40° C
C. Pressure rating: Annexure ME-03
D. Materials:
   a) Body: Ductile Iron (Epoxy coated)
   b) Blade: Stainless Steel ASTM A 240 Gr. 316L
   c) Spindle: Stainless Steel ASTM A 276 Gr. 316
   d) Seat: Resilient EPDM, Bidirectional
   e) Compatibility Flanged: BS EN 1092
   f) Gland: Ductile Iron
   g) Gland packing : Suitable for sewage PTFE impregnated syntex fiber
   h) Fasteners: SS 316
   i) Hand wheel: CI – IS 210 Gr. FG 260/ASTM-A126/BS-2789
   j) Protective Coating: CI & CS: interior and exterior epoxy coated
E. Test Pressure Body -1.5 times pressure rating Seat -1.1 times pressure rating

Other requirements:

a) The valve body port shall be not less than 95% of nominal pipe diameter.
b) Valves shall be free from sharp projections, which are likely to catch and hold stringy materials.
c) Valve flange faces shall be parallel to each other and flange faces shall be at right angles to the valve centerline.

3.3.2 Supports:

A. Unless otherwise specified, supports shall be the same as those used in the piping system where the valve is located.

3.3.3 Gaskets:

A. Unless otherwise specified or directed by the Engineer, provide full-face gaskets for the piping in which the valve is to be installed.

3.3.4 Electrical Actuators:

A. Electrical motor operated actuators to be in accordance with Mechanical Specification-Electric Actuator.

3.4 EXECUTION

3.4.1 Examination:

A. Inspection:
Prior to installation of the work in this Section, carefully inspect and verify that all other work is complete to a point where this installation may properly commence.

B. Discrepancies:
In the event of a discrepancy, immediately notify the Engineer. Do not proceed with installation in areas of discrepancies until all such discrepancies have been fully resolved.

3.4.2 Installation:

A. Valves shall be installed at the locations and orientations as per their application and as shown on the Drawings.
B. Special care shall be taken when ordering and installing valves to ensure that operators are correctly oriented, that the adjustable seats are located on the side of the access provided to the valve and that the valves can be operated as intended and the required maintenance space is available.
C. Any area of interference between valve components and surrounding structures shall be promptly reported to the Engineer. Corrective measures to alleviate the above shall be to the Engineer's satisfaction.
D. Valve supports shall be installed as necessary to adequately support the valves as shown and in conjunction with the piping system.
E. Protect valves to prevent exposure of seals to sunlight or bright artificial light.
F. Inspect piping prior to installation and clean out any foreign objects or debris that may be present. Ensure that valve operates properly after installation.

3.4.3 Testing:

A. Test valves as integral components of the piping system wherein they are located, and to the manufacturer’s recommendations.

4 SLUICE GATE:

4.1 Scope of Works:

A. Dismantling of existing Sluice gates near Mechanical screens, wet well chamber and Surge tank and supply, installation, testing and commissioning of 1500 X 1500mm 7 nos. new Electrically actuated sluice gates with rising spindles at upstream and downstream of the screens (four at the upstream and three at the downstream) ,1500 X 1500mm 2 nos. new Electrically actuated sluice gates with rising spindles before 1300mm pipeline (between screen chamber and pump house wet well), 1500 X 1500mm 2 nos. new Electrically actuated sluice gates with rising spindles in wet well chamber and 2200 X 2200mm 1 no. new Electrically actuated sluice gates with rising spindles at suction end of Surge tank as specified in the datasheet and drawings.

B. The Drawings, Datasheets and Specifications are intended to set the acceptable minimum standard. Ensure that the installed equipment is trouble-free and meets performance requirements.

4.2 General:

4.2.1 Codes and Standards

A. The following applicable standards established by the Bureau of Indian Standards govern the materials and workmanship for the work under this section.

1	IS 13349	Cast Iron Single-Faced Thimble-Mounted Sluice Gates
2	AWWA C560	Standard for Cast-Iron Slide Gates
3	BS 7775	Specification for penstocks
4	IS 9338	Cast Iron Flush-Bottom Sluice Gates

B. Where provisions of the pertinent codes and standards conflict with these Specifications and Drawings or with each other comply with the more stringent provisions.

C. Use the latest issue of Standards.

4.3 Products:

4.3.1 Materials and Design for Sluice Gates:

A. All materials shall conform to the codes and standards Listed below in or better.

1	Wall thimble, frame, gate wedge, stem guide, AWWA 560/ lifting operator	IS: 210 Gr FG 260
2	Seating face of frame and gate, stem, stem coupling, stem extension, stem nut, drive nut, all fasteners and anchor bolts/nuts.	AISI-Gr 316 Stainless Steel
3	Lift Nut	IS:318-LTB-2 Bronze
4	Resilient seal for flush-bottom gate	ASTM D 2000 EPDM rubber

B. All castings shall be of uniform thickness with plane faces without any casting defects such as blow holes etc. Welding of any defects will not be allowed. Casting shall be properly machined to give smooth operating faces.
C. All gates shall be with F type wall thimble to be embedded in concrete walls.
D. All gates shall be with rising spindles.
E. Sluice gates having seating or unseating heads and maximum operating head for each gate shall be as specified in the data sheets.
F. Sluice gates with flush-button seals shall be as specified in the data sheets.
G. The seating and unseating pressure head shall be as per datasheet (which is the difference between maximum water elevation and gate center line elevation).

4.3.2 Wall Thimbles for Gates:

A. Provide each gate with a wall thimble with water stop puddle flange having a machined surface flange to suit gate frame fastening. Thimbles shall have threaded holes for frame fixing bolts/studs.

4.3.3 Frame, Guides and Gate Slide:

A. Flat back frame shall be for mounting on the face of wall thimble. The mating surfaces of frame and thimble shall be fine machined to give leak proof joint. The frame flange shall have accurately drilled holes to match those on thimble flange for fixing with studs and nuts.
B. Extension guides shall extend above the frame, designed to guide and hold the gate in the open position.
C. Provide a 6mm thick continuous hard neoprene rubber gasket between the thimble and frame.

4.3.4 Gates:

A. Gates shall be of rugged design with suitable ribs to prevent distortion and to withstand the specified water head. Cast integral heavy section pocket shall be provided on the gate top to house the stem connecting block for lifting.

4.3.5 Sealing Faces:

A. Wear resistant metal seals shall be embedded in machined dovetail grooves and screwed in sealing face of frame and slide gate to give watertight seal with smooth operation and long life.
   Permissible leakage through the door seals shall be as per AWWA – C 501-92, C501-92/ BS 7775/ IS 13349 standards.
B. Flush Invert seal:
   For flush invert gates resilient seal of ethylene propylene dimethyl (EPDM) or better quality material for durability in sewage and resistance to grit abrasion shall be provided in the frame invert member. The sides and top seals will be metal to metal embedded in dovetail grooves.

4.3.6 Wedges:

A. All wedges shall be individually adjustable. The gates with seating water head shall have side wedges.
B. The unseating head gates shall be provided with wedges on all four sides of the gate. Flush bottom gates shall not have wedges on the bottom edge.

4.3.7 Stems and Guide Brackets for Sluice Gates:

A. The stem length shall be suitable for mounting the gate operator at the operating platform. The depth of gate invert to the operating platform is given in the data sheets. The length of stem threads shall be minimum 400 m longer than the gate opening height.
B. Design the stems with a maximum l/r ratio of 200 between the stem guides.
C. The stem shall be provided with suitable couplings for connecting stem lengths between the gate and the gate operator.
D. Stem guide brackets shall be provided at suitable lengths to prevent buckling.

4.3.8 Stem Protectors for the Sluice Gates:

A. Provide clear plastic or acrylic stem covers complete with stem position indication for each stem. Diameter and length to be recommended by gate manufacturer.

4.3.9 Gate Operators:

A. All operators shall be provided with a vertical flanged mounted stand/pedestal of heavy duty CI or 304 stainless steel.
B. Electrically-operated gates shall have integral gearing with easily fixed/removable hand-wheel to allow the gate to be operated manually without removing actuator.
C. Hand wheel operators shall be approximately 900 mm above the floor.
D. All hand wheels shall have an arrow indicating direction of operation for raising/lowering.
E. Manually operated gates shall be provided with gearing and a horizontal hand wheel and drive nut. The hand wheel shall be easily removable to allow the gate to be operated by a portable electrical actuator.

4.4 Execution:

4.4.1 Delivery, Receiving and Storage of Equipment:

A. The manufacturer shall deliver all equipment supplied under this Contract to the site and co-ordinate supply of items which are required to be embedded during concreting.
B. Supervise the receiving, unloading and storage of the equipment.
C. The Contractor shall notify the Engineer four weeks in advance of delivery and provide four copies of complete and itemized shipping lists. Each item shall be clearly marked, identified and referenced to the shipping lists.

D. Each component shall be adequately packed and crated to provide protection during shipping, handling and storage.

4.4.2 Installation and Commissioning:

A. Obtain required installation instructions from the manufacturer to ensure the correctness of the equipment installation.
B. Gates shall be installed at the locations indicated on the Drawings and as specified.
C. The manufacturer shall verify that the mounting surface for the gate frame is flat and is of suitable finish for mounting the frame. The Contractor shall ensure the proper alignment of the gate.
D. Have the manufacturer provide the services of experienced, factory trained representatives to supervise the installation and the commissioning of the equipment as well as during any testing required.
E. As part of the commissioning, the manufacturer's representative shall instruct plant staff in the proper care and operation of the equipment.
F. The manufacturer shall include for five man-days for this field representation with a minimum of two trips to the site.

4.4.3 Inspection:

A. Provide the services of the manufacturer's technical representative to certify that the gate assembly with the gate operates correctly is complete and in the proper operating condition after installation, before it is put into service and that it operates without undue effort.

4.4.4 Testing:

A. The completed sluice gates shall be tested as follows:
   a) Movement tests, under no-flow conditions for workability and torque required.
   b) Hydrostatic and leakage tests, in closed unseating head position at specified pressures and finally a differential pressure of one a half times the specified pressure. No leakage or deformation is permitted.

5 NON RETURN VALVE:

5.1 Scope of Works:

A. Dismantling the existing Non-Return valve at 900mm Discharge line of each pump (total 6 nos.) and Supply, installation, testing and commissioning of 1000mm multi door NRV on delivery line.
B. The Drawings, Datasheets and Specifications are intended to set the acceptable minimum standard. Ensure that the installed valves are trouble-free and meet their intended performance.

5.2 General:

5.2.1 Design Requirements:

A. Check valves shall comply with (IS 5312 Part - 2) Multi Door swing type Class PN10 and shall be of the swing type suitable for either vertical or horizontal use.
B. The valve design shall ensure closure in the shortest possible time following deceleration of the water column, ideally reaching its seat without slamming.
C. The Body and Trim Material shall be as Specified in Technical Data Sheet.
D. Check valves shall be provided with features to prevent slamming and hammering. These can be in the form of springs or external dash pot and provision shall be made for lifting of valves by lugs, eye bolts and other such standard devices.

5.2.2 Codes and Standards:

A. The following applicable standards established by the Bureau of Indian Standards govern the materials and workmanship for the work under this section.

1	IS 5312-Part 2	Swing Check Type Reflux (non-return) Valves for Water Works Purpose, Part 2: Multi-Door Pattern

B. Where provisions of the pertinent codes and standards conflict with these Specifications and Drawings or with each other, comply with the more stringent provisions.
C. Use the latest issue of Standards.

5.3 Products:

5.3.1 General:

A. Valves shall be bubble tight at rated pressures and shall perform in applications involving operation after long periods of inactivity, regardless of valve size.
B. The valves shall be suitable for installation in potable water service and sewage lines.
C. Supply all valves and operators as shown or inferred in the Contract Drawings or Specifications and as required to provide a functional and safe piping system.
D. For a particular valve type, the same supplier, model and design shall be maintained throughout the project.

E. The valves shall have non-slam design without any external damping device.

5.3.2 Supports:

A. Unless otherwise specified, supports shall be the same as those used in the piping system where the valve is located.

5.3.3 Gaskets:

A. Unless otherwise specified or directed by the Engineer, provide full-face gaskets for the piping in which the valve is to be installed.

5.4 Execution:

5.4.1 Examination:

A. Inspection:
Prior to installation of the work in this Section, carefully inspect and verify that all other work is complete to a point where this installation may properly commence.

B. Discrepancies:
In the event of a discrepancy, immediately notify the Engineer. Do not proceed with installation in areas of discrepancies until all such discrepancies have been fully resolved.

5.4.2 Installation:

A. Valves shall be installed at the locations and orientations as per their application and as shown on the Drawings.
B. Special care shall be taken when ordering and installing valves to ensure that operators are correctly oriented, that the adjustable seats are located on the side of the access provided to the valve and that the valves can be operated as intended and the required maintenance space is available.
C. Any area of interference between valve components and surrounding structures shall be promptly reported to the Engineer. Corrective measures to alleviate the above shall be to the Engineer's satisfaction.
D. Valve supports shall be installed as necessary to adequately support the valves as shown and in conjunction with the piping system.
E. Protect valves to prevent exposure of seals to sunlight or bright artificial light.
F. Inspect piping prior to installation and clean out any foreign objects or debris that may be present. Ensure that valve operates properly after installation.

5.4.3 Testing:

A. Test valves as integral components of the piping system wherein they are located, and to the manufacturer’s recommendations.

6 MOTORIZED MECHANICAL BAR SCREENS:

6.1 Scope of Works:

A. Dismantling of the existing Bar Screens (3 nos.) and supply, installation, testing and commissioning, operation and maintenance of 3 Nos. Motorized mechanical bar screen as specified herein after and as per the Datasheet.
B. The Drawings, Datasheets and Specifications are intended to set the acceptable minimum standard. Ensure that the installed equipment is trouble-free and meets performance requirements.

6.2 General:

6.2.1 Codes and Standards:

A. The Design of the screens shall be as per Manufacturer's standard. The design, manufacture and performance of screens and accessories shall comply with all currently applicable statutory, regulations and safety codes in the locality where the system will be installed. Nothing in the specification shall be construed to relieve the VENDOR of this responsibility
B. Where provisions of the pertinent codes and standards conflict with these Specifications and Drawings or with each other comply with the more stringent provisions.
C. Use the latest issue of Standards.

6.3 Products:

6.3.1 General Design Data:

A. Provide all mechanical bar screens, accessories and control panels from a single supplier who shall be responsible for all equipment of this section.
B. Provide 25% margin on BKW of the Drive.
C. Provide mechanical bar screens having operating characteristics as specified in the data sheet.
D. Provide mechanically-operated, self-cleaning vertical bar screens of the chain-operated rake type, designed to retain and remove floating matter and other debris from a channel flow. The screenings are to be cleared by an ascending series of rakes positively engaging the bar rack from the upstream side or downstream side, starting at the channel invert and traveling upwards to the chute where screenings are discharged on the downstream side of the screen into a suitable receptacle.
E. Screens shall be suitable for continuous operation in a highly corrosive atmosphere. The screen shall be installed by lowering down in the channel with the main side supports bolted/ anchored in the channel side walls and base. All components will be constructed from stainless steel 316L or better quality materials for corrosion and wear resistance,

strength and long useful life. All fasteners including anchor bolts for assembly and installation will be supplied with the screen and shall be in grade 316 stainless steel.

F. All replaceable and wearing parts shall be of standard, accurate dimensions. Complete bar screen shall be factory tested prior to delivery at site.
G. The equipment shall require the minimum maintenance, repair or replacement. Components needing periodic maintenance should be easily accessible from the operating level.
H. Stainless Steel Finishes:
    a) All the Stainless steel surfaces shall be short blasted, pickled and passivated.
    b) Dead plate and discharge chute: Smooth polished finish. Add to the discharge chute top surface, a coating of Teflon or 1.5mm thick Teflon sheeting, riveted in place.
I. Non-sparking Materials:
    a) Provide the screens of non-sparking materials, especially components that may contact each other.
J. The conveyor belt shall be provided with Drop box canopy.

6.3.2 Mechanical Bar Screen:

A. Frame and Supports:
    a) Provide screens with a side frame width to match the channel width designed for bolting to the concrete walls of the channel. Recessed frames cast into the concrete are not acceptable.
    b) Framework of screen shall be constructed of Grade 316L stainless steel with a minimum thickness of 5mm. Various parts fastened by welding or bolting shall be braced as necessary to ensure a rigid structure. The side frames shall be minimum 5mm thick formed to a U channel profile. The frame shall include cross-connect support beams with U channel-profile with a minimum thickness of 5 mm on the front above the maximum water level.
    c) The frame shall include horizontal supports at the operating floor level. The horizontal supports shall extend beyond the walls of the concrete channel. The horizontal supports shall be designed to allow at least 100mm horizontal distance between the vertical face of the channel wall and anchor bolts.
    d) The base part of the frame shall be of the flush-bottom type with a minimum 8mm thick flat plate resting directly on the channel invert.
    e) The top of the frame shall be provided with at least four heavy duty lifting lugs/eyelets, permanently attached.
B. Bar rack:
    a) Screen bars shall be constructed of continuous 316L stainless steel bars.
    b) The bars shall be trapezoidal in width minimum 12 mm > 6 mm or teardrop in design minimum 12 mm, and 50mm deep.
    c) Bars shall extend from the bottom of the screen grid at the channel invert to at least 200 mm above the maximum water level where they will be fastened to the lower side of the dead plate.

C. Dead Plate:
   a) Dead plate fabricated from minimum 5 mm thick 316L stainless steel plate with stainless steel reinforcement on the down stream side. The plate to extend from the top of the rack bars up to the top of the discharge chute.

D. Chute:
   a) A discharge chute with side panels shall be provided to divert screenings discharged from the screen to a container. The discharge chute shall be fabricated from minimum 4mm thick 316L stainless steel plate and shall be mounted at an angle of not less than 30 degrees to the vertical. Panels to be positioned on both sides to protect from splashing.
   b) Easily removable transparent covers of 6mm thick impact resistant long lasting polycarbonate material shall be provided to prevent screenings from flying out from the chute.

E. Rake:
   a) The multi rake screen capacity shall be as specified in data sheets.
   b) The screen rakes shall be of shovel shaped design such that screening will not wrap around its tines or the stationary bars and will not fall back into the channel during the cleaning cycle.
   c) Screenings transported to the top of the screen shall be discharged positively by means of a scraper mechanism to the discharge chute.
   d) The rakes shall run in guides on both sides to ensure proper engagement. The rake shall be fabricated in 316L stainless steel a minimum 12 mm thick with minimum 6 mm thick reinforcement profiles and 10 mm thick side plates. The raking tines shall have the tooth profile precision cut from a single piece of sufficient thickness and depth to ensure adequate stiffness and strength to cope with the loads and forces encountered.
   e) The rake tines shall penetrate into the screen bar spacing to ensure that screenings are completely cleared during each lifting operation. Rake tines shall be mechanically engaged into the screen bars. During each cleaning stroke, the raking tines shall engage into the bottom of the bar screen grids at the channel invert.

F. Rake Drive Mechanism:
   a) The mechanism for up and down travel of the rake and engaging and disengaging the rake with bar rack will be located in the side frames. The machined components such as shafts, sprockets, chains, guided bearings etc shall be of corrosion-resistant steel duly hardened and stress relieved.
   b) The drive design shall be such that the movement of the rakes is smooth and the engagement of tines with the bar rack and dead plate is firm and uniform along the width of rake throughout the rake travel without requiring frequent adjustments.
   c) The rakes, drive chains, chain guides, chain sprockets, bearings and axles shall be fully replaceable without having to remove the screen from the channel.
   d) The drive mechanism shall consist of:

1. The drive shaft shall be 316L stainless steel having high corrosion resistance, tensile and torsion strength.
2. The upper and lower sprockets shall be solid single piece sprockets with tooth width of minimum 25 mm. The submerged Sprocket shall have ceramic bushes.
3. The chain shall be roller type with minimum 125 mm pitch. The 316L stainless steel rollers shall have high corrosion and wear resistance properties. The chain links shall be in grade 316L stainless steel. The ultimate strength of the chain shall be minimum 140 KN.
4. The chain tightening frame, with heavy duty tensioning screw having Acme threads, shall house flange type grease lubricated heavy duty bearings for the upper shaft. The frame assembly shall be fabricated in 316L stainless steel.
5. Each of the lower sprockets, mounted on two separate single piece stub shafts with bonded ceramic collars, will have self lubricating bearings of high wear resistant material such as polyethylene or better and will be suitable for being submerged in sewage.
6. The chain guide shall be of minimum 65 x 35 x 5 mm L-section in 316L hardened stainless steel to withstand wear and abrasion shall be fixed to the screen frame for full height of travel.

G. Scraper:
   a) Scraper mechanism, with scraper blade of wear resisting, strong synthetic material, shall positively discharge the screenings from the rake, at the top of the screen dead plate, to the chute.

H. Screen Side Panels:
   a) Where moving parts of the screen are accessible from the operating floor level, 316L stainless steel cover panels shall be provided for maintenance access. The panels shall be removable or hinged.

I. Elevated Platform:
   a) Where certain components of the screen, such as the motor, drive system, electrical parts etc are 3.0m or greater above the operating floor level, Provide an elevated work platform for maintenance access to those areas. The platform to be provided with its own support system, hand railing, chequer plate and access ladder. All material shall be of 316L stainless steel.

6.3.3 Electrical Motor and Drive:

A. The Equipment shall be VFD compatible. The motor specifications shall be as per specifications of Electric Motor (LT) in Electrical specifications.
B. Provide all electrical components (i.e. junction boxes, terminal boxes, conduit/wiring, etc) mounted on the screen.

6.3.4 Controls and Control Panel:

A. A free-standing control panel shall be provided suitable for an outdoor wet weather location and padlockable. The Control panel shall be floor mounted with IP 54 protection. The control panel shall include all equipment required to operate and control the bar screen with suitable shade.
B. A rated ultrasonic differential level sensor system shall be provided complete with 316L stainless steel mounting for installation in channel. The sensors shall form part of the automated controls of the screen operation.
C. A VFD (variable frequency drive) and a PLC (programmable logic controller) shall be provided inside the control panel along with other components as specified herein. VFD shall have solid state overload integral and shall include discrete and analogue input and outputs.
D. Operation Control and Instrumentation-
    a) Provide the control panel with a main 3-way selector switch for Auto/ Manual/Stop modes of operation. In the Auto mode there shall be a sub-selector switch provided for Auto Level Differential Mode or Timer Mode.
E. Automatic Level Differential Control System:
    a) In this mode, PLC shall control the VFD to operate the screen for variable torque loads at two speeds and through the automatic reversing/forward shuttle sequence.
    b) The rake drive will start operating at low speed in the forward direction when a preset differential in the upstream and downstream levels across the bar rack is sensed by the ultrasonic level sensors.
    c) If the level differential reaches the higher set point the drive will move at higher speed.
    d) When an obstruction is encountered in the rake operation and over-current is detected, the rake drive shall move to low speed then stop and then run in reverse for set distance and again move forward to clear the obstruction. This forward reverse cycle shall repeat twice and if the obstruction is still not cleared, the drive shall stop and the alarm shall sound. Mechanical over-load sensing for initiating the alarm shall not be acceptable. If the obstruction is removed in forward/reverse operation the screen shall resume operation in the normal forward mode.
F. Timer Control System:
    a) In the timer mode, the screen will operate at preset intervals for set time durations and stop for a fixed time period. The on/off times shall be adjustable and set depending on the rate of accumulation of screenings.
    b) In this mode of operation, when an obstruction is encountered the automatic reversing operation will occur as described above.
G. Manual Control System:
    a) In the manual mode a 3-way sub selector switch is to be provided for forward-stop-reverse operation.
H. Control Equipment:
    a) Control Panel will include not be limited to following:
        1. Heavy duty power On/Off switch
        2. Programmable controller, relays, necessary transformer starters, two solid state timers.

3. Main Selector switch for Auto/Manual/ stop
4. Sub-selector switch for level differential/timer/ with indicating light
5. Sub-selector switch for manual mode: forward/reverse/stop
6. Indicating light : Auto
7. Indicating light : Manual
8. Indicating light : Level differential control
9. Indicating light : Timer control
10. Indicating light : Forward operation
11. Indicating light : Reverse operation
12. Indicating alarm : High water level
13. Indicating alarm : Drive overload
14. Alarm horn
15. Alarm silence button push type
16. Emergency stop mushroom push button (red colour).
17. Ultrasonic differential control

6.3.5 Fasteners:

A. All fasteners, bolts, nuts, washers, screws, anchors etc shall be 316 stainless steel.

6.4 Execution:

6.4.1 Installation:

A. Install the screens and other accessories as per manufacturer's instructions and in the presence of a qualified representative of the manufacturer. Ensure the configuration of the equipment, when installed, will operate efficiently.

6.4.2 Painting:

A. Shop and field painting and protective coatings to all components other than stainless steel.

6.4.3 Inspection and Field Testing:

A. Provide the services of an authorized factory trained technical representative to:
   a) Certify completeness of installation
   b) Certify equipment performance throughout the operating range.
   c) Provide training sessions for the operation staff
      Minimum days of on-site factory trained technical support: 5 days per pump station (or more as required).
B. Upon successful completion of the field tests, submit to the BMC, a report presenting findings of the inspection, testing and any adjustments made.

7 DISMANTLING JOINTS

7.1 GENERAL

7.1.1 Codes and Standards:

A. Where provisions of the pertinent codes and standards conflict with these Specifications and Drawings or with each other, comply with the more stringent provisions.
B. Dismantling joints shall comply the requirements of AWWA C219.
C. Use the latest issue of the standards.

7.2 PRODUCTS

7.2.1 General:

A. This Specification covers dismantling joints for use on pressurized mains.
B. Fittings in this specification are for installation between two flanges.
C. Dismantling joints are essentially a double-flanged pipe of adjustable length that permits removal of flanged components from a pipeline. In the assembled condition, pipework pressure forces are transferred across the dismantling joint by means of a set of tie bars, which replace some or all of the main flange connecting bolts.
D. The fittings shall have a working pressure equal to the pressure rating of the flange specification and a test pressure of 1.5 times the working pressure.
E. Dismantling joints shall comply with American Water Works Association Standard AWWA C219.

7.2.2 Design Concept:

A. Longitudinal adjustment (minimum of 40mm) is provided by the combination of a flanged spigot and the telescopic action of the spigot.
B. Once the final installation position is achieved, normal bolt up procedures for the flanges and tie bars shall apply.
C. Sealing ring compression shall be by means of separate bolts specifically for the purpose. The use of the tie rods for sealing ring compression shall not be permitted.

7.2.3 Materials:

A. All materials shall comply with the latest editions of any relevant codes of practice or Standards.
B. Steel Centre Sleeves: The manufacturer shall determine the proper thickness of the sleeve material and sleeve length for the use prescribed by the purchaser. Centre sleeves shall be circular, free from irregularities, flat spots or any defects that may impair the performance of the fitting.
C. Sleeves may be made from pipe, tubing, plates of mill-rolled section with ends prepared to provide a suitable gasket seating surface by such means as a machined or cold rolled bevel. Each roll formed sleeve shall have butt joints welded after rolling, by fusion or flash

butt welding processes. After welding, each roll-formed and welded sleeve shall be cold expanded at a stress beyond the yield point of the steel used, to result in a permanent expansion of about 1% of the diameter. Cold expansion of the centre sleeve performs a physical test on the weld and ensures that the centre sleeve is truly circular with the correct internal bore diameter.

D. If cold expansion is not available to the manufacturer, then works hydrostatic testing or full non-destructive testing shall be carried out for each centre sleeve (radiographic or ultrasonic testing and magnetic particle or dye penetration examination).
E. If welding other than by the flash butt welding process is used, then the manufacturer shall provide, on request, full documentation as to the welding quality, the qualification of the welding personnel and the non-destructive testing carried out, in accordance with current national standards.

7.2.4 Cast Centre Sleeves:

A. Gasket bearing areas shall be in the form of a smooth taper formed into the casting. Centre sleeves shall be free from any defects that may impair the function of the fitting.

7.2.5 Steel End Rings

A. End rings (often referred to as follower rings or end flanges), shall be roll formed and fusion or flash butt-welded. After welding the end ring shall be cold expanded beyond the yield point of the steel. Where cold expansion is not available to the manufacturer, non-destructive testing of the weld shall be carried out.
B. Circumferential welding of steel end rings shall not be permitted.

7.2.6 Cast End Rings

A. The finished casting shall be free of all irregularities, flat spots and defects that may impair the function of the fitting.

7.2.7 Gaskets

A. All elastomeric gaskets shall be suitable for contact with sewage and shall conform to the requirements as per IS 5382.
B. Manufacturers shall identify from which compound gaskets are fabricated and shall mark the gasket by colour flash, or other visual means, the grade of gasket, the standard applicable and adequate size information to ensure correct gaskets are used in coupling products and for re-order.

7.2.8 Nuts, Bolts and Screws

A. Nuts, bolts and screws for gasket compression shall be manufactured from SS 316.
B. Adequate washers of an approved material shall be provided to avoid damage to coatings.

7.2.9 Materials of Flange-Spigot Piece

A. Spigot pieces shall be fabricated either from rolled steel plate or from steel pipe. Pipe shall be welded to steel flanges.

7.2.10 Materials of Tie Rods

A. Tie rods shall be supplied in sufficient quantities to withstand the full pressure thrust forces associated with the rated test pressure of the flange specification. The maximum tensile stress in the tie rods at test pressure should not exceed 50% of the yield strength of the material of the tie rods. Tie rods shall be ASTM A193 Gr. B16/ SS 316.

7.2.11 Coatings

A. Sleeves, End Flanges and Flange-Spigot Pieces: Sleeves, end flanges and flange-spigot pieces shall be coated with a thermoplastic anti-corrosion protection coating applied by hot dipping in a powder tank to an average thickness of 250 microns applied in accordance with the manufacturer's recommendations. Holding points shall be touched in with the appropriate repair coating.
B. Bolts, Nuts, Screws and Washers: Alloy or carbon steel bolts and nuts shall be coated with a two-layer anti-corrosion low friction coating such as Sheraplex or similar approved.

7.2.12 Fittings

A. Carbon steel fittings: Mild steel fittings or components shall be made from materials conforming to IS:2062 or BS EN 10025 Grade S275.

7.3 EXECUTION

A. Install dismantling joints and flexible connections in accordance with manufacturer's instructions.

8 CENTRIFUGAL BLOWER:

8.1 Scope

A. Scope of Works shall include dismantling of existing exhaust Blowers at the Riser Chamber and supply, installation, testing and commissioning of new supply blowers (two nos.) and exhaust Blowers (two nos.) as per Datasheet.
B. This specification covers the general design, materials, construction features, manufacture, shop inspection and testing at the manufacturer's works and delivery at site of Air Blowers.

8.2 Codes and Standards

The design, materials, construction, manufacture, inspection, testing and performance of air blowers shall comply with all currently applicable statutes, regulations and safety codes in the locality where the equipment is to be installed. The equipment shall also conform to the latest applicable Indian or equivalent standards. Other international standards are also acceptable, if these are established to be equal or superior to the listed standards. Nothing in this specification shall be construed to relieve the VENDOR of this responsibility.

8.3 Construction Features

Each air blower shall be a complete unit with casing, inlet and outlet, impeller or rotor, shaft, stuffing box and drive unit etc.

8.3.1 Casing

A. Casing shall be of robust construction. It shall be Fabricated from Mild Steel with Rust Protective Coating. In case of fabricated casings, it shall be rigidly reinforced and supported by structural members. Weld seams shall be continuous to have air-tight enclosure. Casings shall also have smooth interior to avoid accumulation of dense particles. Inlet shall be spun to have a smooth contour. For large blowers, gasketed and bolted split casings are preferable. Using gaskets shall prevent leakage of air from casing joints.
B. If necessary, provision for ready access to the interiors of casings and other possible trouble points shall be made by means of readily removable, bolted on plates or by hinged and latched doors.

8.3.2 Impeller or Rotor

A. Impeller or rotor shall have die-formed blades welded to the rim and back plate. Rim shall be spun to have a smooth contour. Blades shall be of backward, radial or forward type as specified in datasheet for centrifugal blower. Rotor assembly shall be securely keyed to the shaft by key and/or nuts. Suitable means shall be provided to prevent loosening during operation. Rotor assembly shall be statically and dynamically balanced to ensure efficient, vibration-free performance and long bearing life.

8.3.3 Shaft, Sleeves and Bearings

A. The shaft shall be finished to close tolerance at the rotor, pulley and bearing diameters. The size of shaft shall be calculated on the basis of maximum combined shear stress. This shear stress shall not exceed 30 percent of the elastic limit in tension or 18 percent of ultimate tensile strength.
B. The design of shaft shall also take into consideration the critical speed of the shaft, which shall be at least 20% above the operating speed or 60 to 75% of the operating speed, to minimize vibrations.
C. Replaceable shaft sleeves shall be provided to protect the shaft where it passes through stuffing box. The end of the shaft sleeve shall extend through the packing gland. Shaft sleeves shall be securely locked or keyed to the shaft to prevent loosening or rotating.
D. The bearings may be ball, roller or sleeve bearing. If sleeve bearings are used these shall be machined for close running fit. The bearings shall be designed to take the necessary radial load as well as the net axial thrust. Bearings shall be lubricated properly and designed for a minimum of 40,000 hours of continuous operation.

8.3.4 Stuffing box

Stuffing box shall be provided to ensure leak-proof seal between shaft and casing. Stuffing box shall be designed such that it can be repacked without removing any part other than the gland.

8.3.5 Drive-unit

The drive-unit shall be complete with drive motor and secondary transmission. Secondary transmission shall be belt drive with V-belts and pulleys. A common base plate shall be provided for blower assembly and motor. It shall be rigidly constructed, adequately braced and provided with finish pads for mounting the motor and blower. Suitable holes shall be provided for grouting and these shall be so located that the base plate can be grouted in place without disturbing the blower and motor.

8.3.6 Inlet and outlet flanges shall be of cast steel with available industry standard.

8.3.7 Blower shall include a built-in water drain.

8.3.8 Blower / motor unit shall be primed and painted.

8.3.9 Blower shall be an industrial quality model rated for continuous duty at the required workload.

8.3.10 Blower Motor shall be as per Electric Motor (LT) in Electrical specifications.

8.4 General Requirements

8.4.1 Blower shall also be suitable to operate as an exhauster for the vacuum specified.

8.4.2 Drive motor shall be rated at least 15% higher than the power requirement at duty point or 10% higher than the maximum power requirement at selected speed, whichever is higher. Starting torque requirements of blower shall also be considered while selecting the motor

8.4.3 All rotating parts such as chain or belt drives etc. shall be covered with suitable protective guards. Guards shall be easily removable type.

8.4.4 Noise level produced by any rotating equipment individually or collectively shall not exceed 85 dB(A) measured at a distance of 1.0 meter from the source in any direction without acoustic enclosure, when connected to the system at site in a free field condition. The overall vibration level shall be as per zones B and C of ISO 10816-1. Balance quality requirement shall be G- 6.3 conforming to ISO 1940/1. Vibration dampening pads if required, shall be provided.

8.4.5 Blower design and performance shall meet requirements specified on the Data Sheet attached to this specification.

8.4.6 Air blowers shall be designed for continuous operation with high efficiency to satisfy the system requirements. Design of blower shall be governed by safety of operation and maintenance personnel.

8.5 Performance Guarantee

Performance parameters to be guaranteed by the VENDOR and tolerances permitted shall be as indicated in datasheet.

8.6 Data to be Furnished by the Vendor / Contractor after the issue of Purchase Order / Award of Contract

A. Schedule of drawings and documents to be submitted for review, approval and information with submission dates
B. Quality Assurance Plan (QAP)
C. Calculations for capacity, drive motor rating, selection of speed reducers and couplings.
D. Performance curves for blower with duty point marked. In addition to curves for operating conditions, characteristic curves shall be submitted considering minimum and maximum ambient temperature, minimum and maximum humidity and minimum and maximum frequency conditions.
E. Torque - Speed curve
F. Detailed to-scale dimensioned general arrangement drawing of blower and motor giving foundation details, loading data like static and dynamic loads, unbalanced forces and moments if any, pocket details etc. Drawings shall also include all data and information furnished in data sheets.
G. List of wear parts which calls for frequent replacement.
H. Relevant product catalogue.

I. Part list of blower components such as casing, impeller or rotor, inlet and outlet, shaft etc. with materials and codes of construction
J. Overall space and headroom requirement with details of handling during erection, operation and maintenance of the equipment, locations of connections, their sizes and types, lengths, weights and lifting details of removable rotor element.
K. Installation, operation and maintenance manual with lubrication schedule
L. Performance curves for fans with duty point marked. Fan performance rating corrected corresponding to altitude, temperature, etc.
M. Drawing showing fabrication and constructional details of the fan.
N. Fan rating charts or tables with selection marked.
O. Troubleshooting guide.

9 ELECTRIC HOIST:

9.1 Scope of Works

A. The works shall include dismantling of existing electric hoist and monorail and supply, installation, testing and commissioning of 1 Ton monorail with electric hoist for Blower room.
B. The Drawings, Datasheets and Specifications are intended to set the acceptable minimum standard.

9.2 Codes and Standards:

A. The following applicable standards established by the Bureau of Indian Standards govern the materials and workmanship employed for the work under this section.

1	IS 2266	Specification for steel wire ropes.
2	IS: 807	Code of Practice for design, manufacture erection and testing (structural portion) of crane and hoists.
3	IS: 3938	Electric wire rope hoists.

B. Where provisions of the pertinent codes and standards conflict with these Specifications and Drawings or with each other comply with the more stringent provisions.
C. Use the latest issue of Standards.

9.3 Products

9.3.1 General:

A. Monorail hoists shall be controlled from a pendant push button station and be furnished complete with all required safety devices and overload protection. The power supply shall be through a tagline system. The rail shall be a standard I-beam with stops, securely anchored to the structure.
B. Site Conditions:
   a) Location - Blower room of Pump House
   b) Atmosphere - Indoor
C. Construction: The monorail hoist shall be designed as follows:
   a) Hoist: Single-speed, rope-type for parallel lug mounting from a geared trolley, with upper and lower limit switches to prevent over travel, (automatic reset type)
   b) Gear: Fully-enclosed, oil-lubricated spur gear.
   c) Drum: Steel, with machine-cut grooves and flanges, to accommodate entire cable in one layer.
   d) Bearings: Anti-friction type, lifetime pre-lubricated and sealed.
   e) Motor and Drum Shaft: Grease-lubricated, with ball or roller bearings

f) Brakes: Mechanical load brake and separate electric motor brake, each adjustable and capable of supporting the full load.
g) Cable: Of high strength plow steel, flexible, with min. 5:1 safety factor, for maximum lift plus 2 wraps on drum.
h) Load Block: Heavy-duty with ball bearing sheave and forged steel swivel hook with anti-friction bearings and safety spring latch.
i) Motor: Totally-enclosed, single speed
j) Trolley: Motor-driven, with 4 wheels, spur gear, magnetic brake, ball or roller bearings.

D. Power Supply: 415V, 50Hz
E. Motor: As per Electric Motor (LT) specifications
F. Controls: Control equipment shall be mounted in an enclosed compartment which forms an integral part of the hoist and shall include a transformer for a 120-volt control circuit. The pendant pushbutton station shall be suspended from the control compartment and shall be provided with a supporting chain or cable, to locate the station 1 metre above the operating floor level.
G. Each pushbutton shall be clearly marked to indicate its function and sufficient buttons shall be provided to control operations of hoists and trolley.

9.4 Execution

9.4.1 Installation:

A. The crane and monorail shall be installed at the location of current crane and monorail in Blower room after dismantling the existing one.
B. Be fully responsible for work of unloading, storing as necessary, erecting, assembling, adjusting and testing of the materials and equipment specified. Supply shims as required.
C. Provide the services of manufacturer's representatives to supervise the unloading, handling, erecting, assembling and testing of the cranes and to instruct operating personnel in its proper operation and maintenance.

9.4.2 Operation and Load Testing:

A. After erection has been completed and before being placed into service, the crane machinery shall be fully tested.
   a) Running Test:
      1. All clearances and alignments shall be in order; gearing sufficiently quiet and lubrication is adequate.
      2. Operation of each controller switch, contactor, relay and other control devices is satisfactory; all limit switches operate correctly under the most unfavorable conditions.
      3. All circuits, inter-locks and sequence of operation are correct.
      4. All protective devices operate satisfactorily.
      5. Each motion of the crane operates satisfactorily.
   b) Load Test:

1. The crane shall have each motion tested under the full rated load (loads to be provided by Contractor).
2. 25% Overload: During this test the specified speeds need not be attained, but the crane shall show itself capable of dealing with the overload without difficulty.

c) Rated Load: During these tests the specified speeds are to be attained provided that the current supply to the crane is correctly maintained.

d) Brake Test:
   1. All brakes shall be tested under full load conditions, from maximum speed to rest, three times in quick succession without overheating.

10 ELEVATOR:

10.1 General

10.1.1 Work Included:

A. Dismantling of the existing Elevator arrangement and Supply, installation, testing and commissioning of elevators for the transportation of goods and passengers from the dry well operating floor to motor floor and basement/ Pump floor.
B. The Datasheets and Specifications set the minimum acceptable standard. Ensure that the installed equipment is trouble-free and meets performance requirements.

10.1.2 Codes and Standards:

A. The applicable standards established by the Bureau of Indian Standards govern the materials and workmanship employed in the manufacture of all equipment/items.

1	IS: 14665 : Part 1	Guidelines for Outline dimensions of Passenger, Goods, Service & Hospital Lifts.
2	IS: 14665 : Part 2	Code of practice for Installation, operation and maintenance of Electric Passenger and Goods Lifts.

B. Where provisions of the pertinent codes and standards conflict with these Specifications and Drawings or with each other, comply with the more stringent provisions.
C. Use the latest issue of standards.

10.1.3 Quality Control:

A. To ensure that welded structures are correctly manufactured, the supplier shall prepare a quality control plan to encompass the inspection of all fabricated work. All non-destructive testing shall be carried out by qualified personnel.

10.2 Products

10.2.1 Scope and Design concept:

A. The requirements of this specification apply to the stages of design, manufacture, installation, commissioning, maintenance, inspection and safe use for 884 kg passenger and goods lifts. The lifts will be single entry/exit and operate over the heights as required at pumping station.
B. All elevator equipment shall be have a minimum service life of 30 years.
C. Speed, size and capacity:
   a) Minimum speed: The elevator speed shall be – 0.5 m/s
   b) Size and capacity: The capacity of elevator shall be 884 kgs and existing elevator shaft dimensions are 1900 X 2500 mm with entry on 1900mm side.
   c) The Elevator traveling elevations shall be as follows:

1. Operating floor elevation – 29.9m
2. Motor floor elevation – 14.36m
3. Basement elevation/ Pump floor – 6.15m

   Note:
   - The existing lift room is located at an elevation of 34.9m.
   - There are 3 stops required for elevator: Operating floor, Motor floor and Basement floor/ Pump floor.

10.2.2 Technical characteristics:

A. The lift shall be of the electric traction type with the motor located in the lift room above the lift shaft.
B. The supplier shall specify the type of motor, gearbox and safety gear for approval prior to the order being confirmed.
C. Centrifugal speed governors for the car and counterweight safety gear shall be of the continuous progressive type. Instantaneous centrifugal governors shall not be used.
D. Bi-directional safety gears shall be fitted to the lift cars.
E. The lifts shall be provided with an independent emergency battery backup power supply system to drive the lift to the ground floor landing in the event of a power failure.
F. The emergency battery backup power system shall be electrically interlocked with the normal supply such that the system can only be used if the normal supply is isolated.
G. A communication system linking the lift car, lift motor room, lift landings, lift pit, top of lift car with control room via an autodial system shall be provided.
H. Lift runaway (uncontrolled movement under gravity) in either direction during emergency release shall not be possible under any operating conditions.
I. The lift shall include energy efficient lighting and drive units and have minimal environmental impacts over its expected whole design life.

10.2.3 Passenger Environment:

A. Lift car:
   a) The lift car shall have a capacity of 884 Kg.
   b) The car size shall be 1900 mm width x 2500 mm length x 2,500mm high.
   c) The lift door opening shall be a minimum of 1100 mm wide x 2000 mm high and include a two piece centre opening door set fitted with automatic passenger protection.
   d) Internal finishes shall be of industrial non-flammable materials such as stainless steel.
   e) A minimum of two fluorescent light fittings shall be provided in the car to achieve an average 200 lux on the car floor and car operating panel. Emergency lighting shall achieve an average of 60 lux on the car floor and car operating panel for a period of three hours.
B. Lift controls:
   a) The lift control system shall be automatic on – demand.

b) The lift car control panel shall have floor call buttons, alarm button, door hold open button and key operated isolation control. Floor call buttons shall be labelled to reflect the client's floor descriptions.
c) Car floor position indicators shall be provided.
d) A key switch shall be provided to enable the car doors to be held open when the lift is at a landing.
e) Up and down buttons at all landings with call accept lights and car location indicators shall be provided.
f) A control panel housing the following switches shall be positioned at the upper and lower landings:
    1. An out of service switch.
    2. Alarm reset switch.
g) All landings shall be fitted with an alarm bell.
h) When a lift is out of service this shall be displayed on the electronic display.

10.2.4 Components and Materials

A. Drive Unit:
    a) The drive unit shall be of the single wrap traction type and shall include a motor, electro-mechanical brake, reduction gear, sheave and shaft, all compactly mounted on a single base plate. The worm shaft and sheave shaft shall be provided with suitable bearings. The bearings shall be selected for a minimum of 40,000 hrs life. The driving sheave shall be grooved to ensure sufficient traction and minimize rope wear. Adequate means of lubrication shall be provided for all bearings and gearboxes.
B. Motor:
    a) The motor shall be especially for an elevator service, with high starting torque and low starting current. The Motor shall be as per Electric Motor (LT) in Electrical specifications.
C. Base Plate:
    a) A properly machined drive unit base plate of steel construction shall be supplied.
D. Foundations:
    a) The machine shall be placed directly above the hoist way in the machine room on a suitable steel structure with suitable anti vibration pads in between the machine base plate and its support.
E. Brake:
    a) The direct current brake shall be spring applied and electrically released. It shall be held open by an electromagnet actuated by the controller and designed to provide smooth stops under variable loads. It shall be designed to automatically apply in the event of an interruption of the power supply from any cause.
F. Controller:
    a) An automatic controller shall be provided which shall control all the operations. An automatic rescue device shall be provided to move the lift to the nearest upward or downward landing in the event of a power failure.
G. Ropes and Sheaves:

a) Hoisting ropes shall be adequately sized steel cable with a fibre core. Hoist rope terminations shall be Nylube wedge clamps. Sheaves and bearings shall be properly designed and sized.

H. Safety and Governor:
   a) Provide car safety on the bottom of each car and governor at top of traction hoist-way for each car to apply car safety devices whenever the car has excessive speed.

I. Car Frame:
   a) The car frame consisting of the car enclosure and floor shall be fabricated out of rolled sheet sections. Suitable guides shall be provided for smooth up and down movement of the car. The floor plate shall be chequered type. The car frame shall be robust enough to withstand occasional impact loading by a forklift or platform truck.

J. Operating Devices:
   a) Operating devices shall be furnished as flush type finished metal panels containing buttons marked to correspond with the landings served. An emergency stop switch and an alarm button connected to a bell shall serve as an emergency signal. It shall be possible to operate the elevator both from inside the car and from the various landing floors.

K. Door Open & Emergency Bell:
   a) A bell, furnished and installed in the car, shall ring while a landing button is pressed and the car gate or hoistway door is open. An emergency call bell shall be provided on the ground floor and the control room.

L. Car Gate Contact:
   a) An electric contact shall be provided for the car door. The contact shall prevent movement of the car away from a landing unless the door is in the properly closed position.

M. Car Operation:
   a) The car shall not start unless the car and all hoist-way doors are locked in closed. Pressing the car or hallway buttons shall send the car to the landing selected where the car will automatically stop. Car operation shall be of simplex full collective up and down type. Pressing a landing button shall bring the car to the desired landing. The car position shall be indicated at all the floors and inside the car.

N. Guides:
   a) Contractor shall furnish steel Tee guides with necessary brackets for car and Counterweight.

O. Hoist-way and Car Doors:
   a) The hoist-way and car doors shall be two piece centre opening of steel construction. Each hoist-way door shall be provided with an interlock to prevent movement of the car away from the landing unless all the doors are closed and locked. The interlocks shall also prevent opening of the doors except at the landing where the car has stopped.

P. Hoist-way Landing:
   a) Suitable Push button shall be provided at each landing. It shall be possible to load the Elevator at any floor and send unmanned to any floor.

Q. Counterweight:
   a) For economical operation of the elevator, a suitable counter weight arrangement, moving in a guided structural steel frame, shall be provided.

R. Over-speed Safety:
   a) An over speed safety device to stop the car whenever the car achieves a runaway speed limit resulting from high speed descending of the car shall be provided. The device shall be operated by a centrifugal governor, which shall continuously and automatically sense the car speed. The actuation of the safety device shall cut off the power supply to the motor and apply the brake immediately. An alarm shall be activated. It shall then be possible to bring the car safely to the nearest landing.

S. Terminal and Final Limits:
   a) Terminal limit switches shall be provided to slow down and stop the car automatically at the terminal landing. To arrest the movement of the car beyond the terminal landings, final limit switches shall be provided which on operation shall cut off the power and apply the brake immediately. An inching device shall be provided for accurate positioning of the car with the landings.

T. Terminal Buffers:
   a) Spring buffers shall be installed as a means of stopping the car and counterweight at the extreme limits of travel. The lift car and counterweight buffers shall be capable of bringing the lift car and load to a gradual and positive stop at speeds of up to 130% of the design speed without exceeding a deceleration of 9.81 m/s. The buffers shall be fixed to the pit floor using a steel plate to allow ease of replacement.

U. Indications: Following signals shall be provided:
   a) Hall buttons with Up/Down arrows at all floors
   b) Car position indication with arrow in the car.
   c) Car position indication with arrow in hall on all floors.

V. Following details shall be displayed inside car
   a) Name plate indicating capacity of lift.
   b) Operating instructions in English or any other language.

W. Emergency rescue procedures shall be displayed in the machine room.

10.2.5 Electrical Equipment

A. The Contractor shall provide one point power supply of 415V, 3 phase, 4 wire ± 10% and 50Hz ± 5% to the unit power distribution board in the machine room, further distribution shall be by the lift installer.

B. Electrical equipment including that listed below shall be provided in the elevator installation.
   a) Motors
   b) Power distribution board
   c) variable-voltage, variable-frequency drive
   d) Power and control cables along with accessories including cable glands and lugs including hardware.

e) LV power cables shall be with stranded aluminium conductors, XLPE insulation, PVC inner sheath, armoured and overall FRLS PVC outer sheath. All control cables shall have copper conductors, XLPE insulation, PVC inner sheath, armoured and overall FRLS PVC outer sheath.
f) The cable type shall be selected to meet the statutory requirements
g) For the lighting inside the elevator, hoist-way, pit and machine room, the Contractor shall provide a lighting panel, fixtures, emergency light fixtures, cable glands, lugs and junction boxes including all hardware.
h) Earthing material including hardware and accessories for all equipment. Earthing shall be connected to the nearest main earth grid.
i) Push buttons switches, selector switches and alarm bells etc
j) Miscellaneous items for completing the electrical works in all respects.
k) Provision shall be made in elevator control panel to hook-up the signal for emergency operation from the fire alarm system.

C. Submit evidence from the manufacturer indicating that the items are manufactured at its own facility and that they have supplied similar elevators for the last 15 years. The manufacturer shall have supplied a minimum of 50 similar elevators and shall have valid ISO 9001:2008 certification documents.

10.3 Execution

10.3.1 General:

A. Delivery:
a) The Supplier shall carefully pack all equipment for shipment to protect it against damage which may result from movement, dust, moisture, freezing or heat.
B. Installation and Commissioning:
a) The Supplier shall provide all required installation instructions to the Contractor. The Supplier shall provide the services of an experienced factory trained representative to supervise installation and commissioning.
C. As part of commissioning, the representative shall be required to instruct plant operations staff in the proper care, operation and maintenance of the equipment.
D. Testing and Inspection:
a) Provide the services of a technical representative to carry out a visual check of the completeness of the installation.
E. Upon completion of the above, the Supplier shall submit to the Engineer two signed copies of the report presenting detailed findings of the above inspection.

10.3.2 Painting and Protective Coatings:

A. The Painting and Protective coatings shall be as per manufacturer’s standard.
B. The Contractor shall coordinate all work including surface preparation, shop and field painting.

11 ELECTRIC ACTUATOR:

11.1 General

11.1.1 Codes and Standards:

A. Electrical motor operated actuators to be in accordance with IS 9334
B. Where provisions of the pertinent codes and standards conflict with these Specifications and Drawings or with each other, comply with the more stringent provisions.
C. Use the latest issue of Standards.

11.2 Products

11.2.1 General:

A. Electrical actuators shall be procured through valve/ gate manufacturer only.

11.2.2 Service Conditions:

A. Actuators shall be with IP 65 protection.

11.2.3 Construction Details:

A. General
   a) The actuator shall be suitable for use on nominal 415 V, 3 phase, 50 Hz power supply and shall incorporate motor, integral reversing contactor, local control facilities through Local Push Button Station.
   b) The actuator motor control circuit shall include a device to ensure that motor runs with the correct rotation for the required direction of valve/gate travel irrespective of three phase connection sequence of the power supply.
   c) Setting of the torque levels position limits and configuration of the indication contacts etc. shall be carried out with the removal of actuator covers. Provision shall be made for the protection of configured actuator settings.
   d) The actuator shall be of OPEN-CLOSE duty type wherein normal valve/gate positions are end positions OPEN and CLOSED. After receipt of local/remote command, the actuator shall operate the valve/gate to one of the end positions or if necessary to a pre-set intermediate position as specified.
B. Actuator Sizing
   a) The actuator shall be sized to guarantee valve/gate closure at the specified differential pressure.
   b) The motor power available with safety margin, for seating and unseating the valve/gate, shall be sufficient to ensure limit switch trip at the extreme end position of valve/gate, with supply voltage 10% below normal.
   c) The operating speed shall govern valve/gate closing and opening at approximately 250 -300 mm per minute unless otherwise stated.

d) Enclosure: Actuators shall be O-ring sealed, watertight to IP68 and shall at the same time have an inner watertight and dustproof O-ring seal between the terminal compartment and the internal electrical elements of the actuator. The motor and all other internal electrical elements of the actuator shall be protected from ingress of moisture and dust when the terminal cover is removed at site for cabling.
e) Enclosure must allow for temporary site storage without the need for electrical supply connection.
f) All external fasteners shall be of stainless-steel type.

C. Motors:
a) Motors shall be squirrel cage induction motors with minimum insulation class ‘F’ and temperature rise restricted to class ‘B’ limit.
b) Motors shall be specifically designed for valve/gate actuator operation, which is characterized by high starting torque, low stall torque & low inertia. All motors shall be high starting torque type to facilitate unseating of valve/gate.
c) Motor shall be capable of a minimum 60 of starts per hour.
d) It shall be possible to separate the motor from the lubricant filled gearing of the actuator allowing easy replacement of motor without releasing any lubricant regardless of mounting position.

D. Limit switches:
a) The actuator shall be provided with following limit switches.
1. Two limit switches each with 2 NO + 2 NC contacts as changeover (2 for open and 2 for close direction) for end of travel and interlock purposes.
2. The limit switch shall enable switching off the actuator when reaching defined valve/gate positions, usually end positions. The valve/gate travel shall be measured by mechanical counter gear mechanism which when reaching the set switching points shall operate the electrical limit switching by cams. The setting accuracy shall be minimum 1/10 of the turn of actuator output shaft. Two train counter gear shall be used along with two limit switches.

E. Local Position Indicator:
a) The actuator shall include a position indicator for fully open and fully closed condition.

F. Remote Actuator Status Indication:
a) One set of the two (2) NO/NC contacts of OPEN and CLOSED position Limit Switches and Torque Switches shall be hardwired to respective valve actuator MCC control circuit for power cut-off purpose and another set of NO/NC contacts shall be interfaced with PLC for HMI/ SCADA indication/ interlock.

G. Gear:
a) The actuator gearing shall be totally enclosed in a grease or oil-filled gear case suitable for operation at any angle. All drive gearing and components must be of metal construction and incorporate a lost-motion hammer blow feature. For rising spindle valves/gates, the output shaft shall be hollow to accept a rising stem and incorporate thrust bearings of the ball or roller type at the base of the actuator. The design shall permit the opening of the gear case for inspection or disassembly without releasing the stem thrust or taking the valve/gate out of service.

H. Reduction gear unit:
   a) Reduction gear unit shall be used for mechanical/digital position indication, remote position indication and for operation of intermediate switches.
I. Bevel Gear Set:
   a) The actuator shall have the provision or inbuilt gear set to reduce the manual effort with the help of a side mounted hand wheel instead of standard hand wheel.
J. The Drive Bushing:
   a) The actuator shall be furnished with a drive bushing easily detachable for machining to suit the valve/gate stem or gearbox. Thrust bearings, when housed in a separate thrust base should be of the sealed-for-life type.
K. Anti-Condensation Heater:
   a) Anti-condensation heaters shall be supplied to maintain the interior of the actuator enclosure above the dew point on all actuators installed indoors or outdoors. Heaters shall be sized and located to prevent condensation of moisture during shutdown periods.
   b) Heaters shall be unaffected by the accumulation of moisture and shall have terminals adequately protected against moisture under severe weather conditions. Heaters shall be mounted on non-combustible material and shall operate without thermal damage to the actuator or themselves.
L. Motor protection:
   a) The motor shall be de-energized in the event of a stall when attempting to unseat a jammed valve/gate.
   b) Motors shall have three thermostats connected in series, one in each phase of stator winding, for protection against overheating.
M. Manual operation:
   a) In case of power failure or during emergency operation there shall be provision of manual operation by a hand wheel. The manual drive shall be engaged by means of a lever when the motor is declutched. When the motor is in operation, the manual drive shall be disengaged immediately, and the hand wheel shall not rotate.
   b) The hand wheel drive must be mechanically independent of the motor drive and any hand wheel gearing shall permit emergency manual operation in a reasonable time. Clockwise operation of the hand wheel shall give closing movement of the valve/gate unless otherwise stated.
   c) Hand wheels shall be able to withstand hammer blows made to open jammed or rarely operated valve/gate.
N. Performance:
   a) Rated Output
      1. The required torque requirement shall be calculated, and design calculations shall be submitted to the Engineer’s representative for information.
   b) Power Loss
      1. The power loss in actuators and accessories shall not exceed the value specified in relevant standards.
   c) Permissible overload

1. The maximum permissible overloads with regard to voltage, current and reactive output shall conform to relevant IS.

O. Wiring and Terminations:

a) Internal wiring shall be tropical grade PVC insulated stranded cable of appropriate size for the control and 3-¬phase power. Each wire shall be clearly identified at each end. The terminals shall be embedded in a terminal block of high tracking resistance compound.

b) The terminal compartment shall be separated from the inner electrical components of the actuator by means of a watertight seal and shall be provided with a minimum of three threaded cable entries with provision for a minimum of four. All wiring supplied as part of the actuator to be contained within the main enclosure for physical and environmental protection. External conduit connections between components are not acceptable. A durable terminal identification information nameplate / card showing plan of terminals shall be provided attached to the inside of the terminal box cover indicating

1. Serial number
2. External voltage values
3. Wiring diagram number
4. Terminal layout
5. Inscribe cable core identification alongside terminal numbers on the (nameplate / card).
6. Coloured sleeves shall be provided on the termination for identification purposes.
7. Crimping type copper lugs shall be used as termination.
8. Terminals shall be suitable for termination of wires of size 2.5 mm2 (maximum) for control and 4 mm2 (maximum) for power connections. Fixed terminals of power circuit shall be of thermosetting compound. Material of power terminals shall have excellent resistance to deformation, optimum dimensional stability and strong resistance to surface discharge.
9. Two grounding terminals shall be provided on either side of the motor.

P. Nameplates:

a) The lettering shall be engraved with white letters on black background on the panel surface

11.3 Execution

11.3.1 Installation:

A. Ensure that the supplied equipment is factory assembled.
B. Mount the actuators as shown on the Drawings. Where not shown, mount as recommended by the manufacturer.
C. Ensure that operating lights and push buttons are readily visible and accessible.
D. Coordinate wiring and sequencing of operation with process narrative.

11.3.2 Inspection and Testing:

A. Shop test the fully assembled units to verify the function of the complete mechanism. The orientation of the actuator on a pedestal of a sluice gate /valve to be as directed by the Engineer, in the field.

12 FIBERGLASS REINFORCED PLASTIC DUCT WORK:

12.1 GENERAL

12.1.1 Work Included:

A. Dismantling of existing FRP duct for Inlet and Exhaust Blower at Riser Chamber and Screen chamber and Supply, Installation, Testing and Commissioning of new FRP Duct for Ventilation purpose.
B. Duct sizes shall be as per Bill of Quantities.

12.1.2 Codes and Standards:

A. The following applicable standards established by the Bureau of Indian Standards govern the materials and workmanship for the work under this Section.
    a. National Building Code of India – 2005.
    b. ASTM D 3567 – Practice for determining dimensions of fiberglass pipe and fittings.
    c. ASTM C 582 – Standard specification for contact – molded reinforced thermosetting plastic (RTP) laminates for corrosion resistant equipment.
    d. ASTM D 3982 – Standard specification for contact molded fiberglass ducts and hoods.
    e. ASTM D 2563 – Classifying visual defects in glass reinforced plastic laminate parts.
B. Where provisions of the pertinent codes and standards conflict with these Specifications and Drawings or with each other comply with the more stringent provisions.
C. Use the latest issue of Standards.

12.2 PRODUCTS

12.2.1 General:

A. Manufacturer: Provide FRP duct from reputed manufacturer.
B. Service conditions:
    a. Equipment shall be designed for a minimum of 500 Pa working negative pressure. The minimum wall thickness for above grade FRP ductwork shall conform to the following:
        1. Duct inside diameter of 80-400 mm diameter wall thickness shall be 4.76 mm; duct inside diameter of 450-900 mm diameter wall thickness shall be 6.35 mm.
C. Reinforcement:
    a. Surfacing veil shall be as per ASTM C582.
    b. Chopped strand mat shall be type E glass minimum 459 gr/m2 (1.5 oz/ft2) with sizing compatible with the resin.
    c. Continuous roving for chopper gun spray up shall be type E glass.
    d. Woven roving shall be type E glass minimum 570gr/m2 (24 oz/yd2)
    e. Continuous roving for filament winding shall be type E glass wit silane finish.

D. Construction:

a. FRP ductwork shall be of filament wound construction for sizes larger than 250 mm. Cast pipe with no reinforced internal corrosion barrier or press molded fittings will not be accepted.
b. Maximum allowable deflection for any size ductwork shall be 1% of span for any size of duct under worse case operating conditions.
c. FRP ductwork shall be designed using a safety factor of 10 for internal pressure and 5 for external pressure without exception.
d. Out of roundness of duct shall be limited to 1% of diameter.

E. Laminates:
a. Ductwork shall have resin rich inner surface, an interior corrosion barrier, an interior structural layer and an exterior corrosion layer and UV resistant coating.
b. Inner surface: Nominal 10 mils thick composed of a single ply of the C glass surfacing veil embedded in a resin-rich surface. Resin content shall be 90%.
c. Interior layer: Nominal 90 mils thick composed of at least two layers of chopped strand mat. Resin content shall be 75%.
d. Structural layer: Type E glass to meet minimum wall thickness as specified. The total wall thickness includes the inner surface.
e. Exterior corrosion layer: Single A or C veil shall be applied to duct exterior without exception.
f. Exterior UV resistant coating: Factory applied paraffiniated gel coat with UV inhibitors.

F. Fittings:
a. Fittings shall be hand-lay up construction fabricated from the same resin and have the same strength as the FRP ductwork.
b. The internal diameter of fittings shall be equal to the adjacent duct.

G. Elbows:
a. The centerline of all elbows shall be 1.5 times the diameter.
b. Elbows 600 mm and smaller shall be smooth radius. Elbows with 750mm and larger diameter shall be mitered. Provide minimum 2 miter joints.

H. Flanges:
a. Flanges shall be drilled in accordance with ASTM D3982. Back of flange face shall be flat so that washer seats fully on bolt face and flange backing.
b. Flange faces shall be perpendicular to the axis of the duct within 0.5 degree.
c. Flange faces shall be flat to within 0.8 mm up to and including 450 mm diameter and within 1.6 mm for 500 mm diameter and larger.
d. Gaskets shall be EPDM, full face and minimum 3.2 mm thickness.
e. Bolts, nuts and washers shall be type 316 stainless steel.

I. Joints:
a. Provide butt and strap joints in accordance with NSB PS 15-69
b. Field weld kits shall be supplied by the duct manufacturer. All necessary fiberglass and reinforcing material shall be supplied pre-cut and individually packaged for each joint. Bulk glass rolls will not be acceptable.
c. Resin, catalyst and putty shall be supplied in bulk to complete filed joints plus 25% extra for waste.

12.2.2 Duct Hangers and Supports:

A. The ductwork shall be fixed using clamp supports as per the existing support arrangement at site.

12.3 EXECUTION

12.3.1 Installation:

A. FRP DUCTS shall be installed in a neat and workmanlike manner, properly aligned, and cut from measurements taken at the site to avoid interferences with structural members, architectural features, openings and equipment.
B. Supports and Anchors: All ducting shall be firmly supported with fabricated or commercial clamps.

12.3.2 Pipe Preparation:

A. Prior to installation, each duct length and all fittings shall be carefully inspected, flushed clean of any debris or dust, and straightened, if not true. All duct and fittings shall be equally cleaned before assembly.

12.3.3 Pipe Joints:

A. Butt and Wrap Joints: Prior to joining, ends shall be ground smooth. All dust and debris must be fully removed. Ends shall be resin-coated to prevent corrosion. The joint should be of equal strength as the pipe.
B. Supports and Anchors: All piping shall be firmly supported with fabricated or commercial supports.

12.3.4 Inspection and Field Testing:

A. Inspection: All finished installations shall be carefully inspected for proper joints and sufficient supports, anchoring, interference, and damage to pipe, fittings, and coating. Damage shall be repaired to the satisfaction of the Engineer.
B. Leakage may be determined by loss of pressure, soap solution, chemical indicator, or other positive and accurate method. All fixtures, devices, or other accessories which are to be connected to the lines and which would be damaged if subjected to the test pressure shall be disconnected and ends of the branch lines plugged or capped as required during the testing procedures.
C. Leaks shall be repaired to the satisfaction of the Engineer and the system shall be re-tested until no leaks are found.

13 TROLLEY

13.1 GENERAL

13.1.1 Work Included:

A. Supply of 500kg Mild steel platform trolley with rust resistant coating as specified for carrying rotating or static equipment to workshop.

13.1.2 Codes and Standards:

A. The applicable standards established by the Bureau of Indian Standards govern the materials and workmanship employed in the manufacture of all equipment/items.
B. Where provisions of the pertinent codes and standards conflict with these Specifications and Drawings or with each other comply with the more stringent provisions.
C. Use the latest issue of Standards.

13.2 PRODUCTS

13.2.1 Materials:

A.	Nuts bolts and washers:	CS Galvanized
B.	Mounting plate	Mild Steel with rust protected coating
C.	Frame & stiffeners	Mild Steel with rust protected coating
D.	Handle:	40 NB, Mild Steel with rust protected coating
E.	Wheels:	125 mm dia rubber wheels with load capacity 500 kg.

13.2.2 Fabrication:

A. Trolleys to be factory assembled.
B. Use prefabricated fittings for joining railing components.
C. Use prefabricated radius bends or bend pipes to form radius bends free from buckles or twists with smooth finished surfaces.
D. Fabricate joints exposed to weather as per good engineering practice.
E. Remove burrs from exposed cut edges.

14 AIR COOLED DUCTABLE SPLIT TYPE AC UNIT

14.1 General

The Air cooled ducted type A.C. unit shall be with hermetic type scroll compressor. Each unit shall be completely factory assembled, piped, wired and tested and shall comprise of scroll compressor, condenser fans, insulated cooler, air cooled condenser with microprocessor control panel. If multiple compressors are offered, they shall have independent refrigerant circuits. Also compressor shall be cut–off automatically under part load conditions. The refrigerant used shall be R 410a or R 407 or R-134a or Eco friendly refrigerant. The indoor unit shall comprise of fan, Cooling Coil, Filter and Expansion Valve. The Outdoor unit shall be installed at the place decided by site engineer/concerned authority. The scope shall also include all supports for Indoor. The unit shall be selected for ambient conditions as specified. The unit shall be factory assembled and only the refrigerant piping carried out at site. The unit shall be insulated from inside with proper method of insulation. The unit shall be suitable to work on 415 V, 4 wire, 50 Hz AC supply. The Minimum Heat Load of the room shall be the heat generated from all the panels, lighting load, etc. which shall not be considered less than 180kW (which shall be confirmed from panel vendor during the detailed engineering).

a) CABINET:-The shell shall be constructed out of corrosion resistance epoxy coated GI sheets of 18 SWG thick and the panel can be made out of 20 SWG CR epoxy coated sheet metal. All panels should be easily removable type for maintenance. Coil and blower section shall be internally lined with 12 mm thick resin bonded fiberglass and covered with nylon netting OR suitable similar material.
b) EVAPORATOR COIL:-The cooling coil shall be made out of Copper tubes with external mechanically bonded Aluminums fins. The cooling coil shall have sufficient face area. A corrosion resistant drain pan shall be provided beneath the cooling coil, along with an outlet nozzle of not less than 40 mm dia. for drain connection. Washable type synthetic fabric media pre-filters of filtration efficiency of 90 % down to maximum 20 microns shall be provided ahead of the cooing coil. The filter shall be easily removable for clearing purposes.
c) EVAPORATOR FAN:-The evaporator fan shall be of centrifugal type with DIDW impeller designed for noise free operation. The fan and the drive shall be statically and dynamically balance. The fan shall be either directly driven OR belt driven by a suitably rated TEFC squirrel cage motor rated for 415 V, 3 phase, 50 Hz power supply. The motor shall be factory wired and brought out to a terminal block mounted on the outside of the unit, to facilitate easy wiring at site. The fan shall be quiet in operation and noise should within permissible limit. The static head generated shall be sufficient for flow across the pre filters.
d) COMPRESSOR:- Compressors offered shall be hermetic scroll type, suitable for operating with R 410a or R 407 or R 134a or Eco friendly refrigerant. The motor shall be rated for 415 V, 3 phase, 50 Hz power supply and should be capable of operating under +/- 10 % fluctuations in the supply voltage. If multiple compressors are offered for the specified spilt units, then each of the compressors shall be of equal capacity. Moreover an electronic temperature controller shall be provided which shall automatically trip the compressors under

partial load condition. The compressors shall be housed in the air-cooled condensing unit. The compressors shall be mounted on spring vibration isolators.

e) CONTROL PANEL:-The units shall be supplied with microprocessor based control system. The system shall have digital display of the set point temperature.
The following safety features shall be provided and the same shall have LED indications.
Under voltage/Over voltage trip.
- Phase Failure/Phase reversal trip.
- High Pressure trip
- Fan fails indication

The following mode selection shall be provided
- Fan Mode.
- Cool Mode

The panel shall allow temperature set point adjustment.

f) AIR COOLED CONDENSING UNIT:-The condensing unit shall be designed for outdoor installation and hence be of weatherproof construction. This shall house the Compressor(s) and the air cooled condenser. The condenser should be designed to match the capacity of the air-conditioner even during worst operating conditions. Air-cooled condenser coils shall be with copper tubes & aluminum fins. It shall also house the directly driven axial flow fan. The condenser coil shall be of Copper tubes and mechanically bonded aluminum fins. The coil should be adequately sized to handle the design head rejection and size provides sub cooling. The coil should be designed to work under a peak ambient temperature of 41 Deg. C.

g) LOCATION OF UNIT:- The outdoor units shall be installed as per instruction of Engineer/concerned authority at convenient site. The outlet of the units shall be connected to indoor units through ducting of sufficient size & in consultation with the site Engineer. The outdoor units shall be placed ground with Neoprene serrated rubber pads to ensure vibration free operation.

h) PRE-COMMISSIONING TEST:-The following tests/checks are generally required to be carried out before commissioning of the plants. The site engineer shall have right to waive certain tests as per site conditions.
- Check supply voltage, it should not be less than the stated voltage of the compressor motor.
- Check power and control circuit.
- Ensure that all electrical equipments are effectively earthed.
- Check the operation of over load and low volt release in the motor starters.
- Check all terminals and ensure they are all fully tight.
- Check operation of all protection devices.
- Thermostat should be set to maintain the temperature at desired level.
- Record W.B. and D.B.
- Operate the plant continuously for 12 (twelve) hours; after which all points referred to above should be once again being checked. In addition, check all parts of the refrigerant piping system for leak detections.

i) TESTING :- All routine tests as per standard practice shall be carried out. The tests shall be taken in presence of the Municipal Engineers/ concerned authority over a period of three days. All parameters like suction pressure, discharge pressure, temperature, humidity, power etc. shall be tested along with the entire air conditioning system.

14.2 VARIABLE REFRIGERANT FLOW (VRF) SYSTEM EQUIPMENT

14.2.1 Outdoor Units

Outdoor units of the VRF/VRV system shall be compact air cooled type. All the compressors of the outdoor units must be hermetically sealed scroll type. Each module of outdoor unit must have at least 1 inverter compressor, suitable to operate at varying heat load proportional to indoor requirement. The outdoor units shall be suitable to operate within an ambient temperature range of – 5 Deg C to 43 Deg C, in cooling mode & 20 Deg C to 15 Deg C in heating mode The outdoor units must be suitable for up to 150 m refrigerant piping between outdoor unit & the farthest indoor units, total piping of 300 m for all the indoor units. Allowable level difference between outdoor unit & indoor units shall be 50 m in case of outdoor unit on top & 40 m in case of outdoor unit at bottom. Allowable level difference between various indoor units connected to one out door unit shall be up to 15 m. Back up operation, in case of failure of one of the compressors of outdoor unit, for single module outdoor units or failure of one of the modules in case of multiple module outdoor units shall be possible. The VRF/VRV outdoor unit shall always be supplying at least 33% of back up operation, of the full load capacity. The outdoor unit shall employ system of equal run time for all the compressors, inverter or on / off type, within each outdoor unit – Single Module or Multi Module. The outdoor units shall be suitable to operate within an ambient temperature range of – 5 Deg C to 43 Deg C, in cooling mode. Air cooled condenser shall have Axial Flow, upward throw fan, directly coupled to fan motors with minimum IP 55 protection. The outdoor unit condenser fan shall be able to develop external static pressure up to 7.5 mm of H2O. Starter for the Outdoor Unit compressor shall be “Direct on Line” type. Inverter compressor of the unit shall start first & at the minimum frequency, to reduce the inrush current during starting. Specification for starter panels furnished in below electrical section. Refrigerant control in the outdoor unit shall be through Electronic Expansion Valve. Complete refrigerant circuit, oil balancing/ equalizing circuit shall be factory assembled & tested. Noise level of outdoor units shall not exceed 65 dB (A) at a distance of 1.5 m from the unit.

Outdoor units shall be complete with following safety devices:

- High pressure switch
- Fan driver overload protector
- Over current relay
- Inverter Overload Protector
- Fusible Plug
- Short Circuit Protection

Unit shall be supplied with

- Installation manual
- Operation Manual
- Connection Pipes
- Clamps

VRF/ VRV SYSTEM

The Variable Refrigerant Flow (VRF / VRV) System should be air cooled, split type air conditioning system consisting of condensing units connected to multiple indoor units, having the capability of individual set point control. The system should have the ability to connect each condensing unit to required indoor units of different types and capacities on one refrigerant circuit. The system is to be of the cooling type. Each Condensing unit should incorporate at least one inverter based scroll compressor & other / others fixed scroll compressors, to obtain 10% to 100% step less capacity control for enhanced Power saving. The VRF/VRV system shall provide stable, trouble free & safe operation, with flexibility of operating desired indoor units. The outdoor units must be capable of delivering exact capacity proportional to the number of indoor units switched on & the heat load in the air conditioned area. The proportional operation shall be achieved by varying speed of the compressor in the outdoor units. The entire system shall be controlled by a system controller. The system controller shall be able to control start / stop on time schedule and also provide common fault from the system. The system shall be BMS compatible. Refrigerant The Entire Condensing unit and Evaporating unit should be Factory assembled and tested .The units should come with an initial charge of refrigerant R410A / other equivalent eco friendly refrigerant. Any additional refrigerant is to be added at site. Refrigerant Piping Distance Limits To be capable of refrigerant piping runs up to 150m between the condensing unit and indoor units with 50m level difference without any oil traps or double risers. The Oil Equalizing line should be inside the Condensing unit, to avoid „inverted" oil traps at site.

Condensing Units: They shall be fully weatherproofed, factory assembled and pre-wired with all necessary electronic and refrigerant controls. The casing shall be from mild steel panels coated with a baked enamel finish. Provide the condenser coil fins with a corrosion resistant finish. The Condensing Units shall incorporate suitable compressors in condensing units with all invertor scroll compressor in case of multiple compressor. The design shall be modular type allowing for side by side installation of the condensing Units. Fan Motor Speed Control: The condensing unit fan motors to have at least two speed operations to maintain constant head pressure control in all ambient temperatures and modes of operation. Compressors The compressor shall be highly efficient at least one inverter based scroll compressor. The compressors shall have electronic controls, capable of loading and unloading to follow the variations on cooling using the latest axial compliant sealing technology. The microprocessor panel should incorporate control for precise monitoring of status of the system. Each compressor shall have in-built overloads, HP and LP controllers and mounted on vibration isolators. Heat Exchanger The heat exchanger shall be constructed from seamless copper tubes mechanically bonded to aluminium fins to form a cross fin coil. The aluminium fins shall be treated with an anti-corrosion film. Refrigerant Circuit The refrigerant circuit shall be complete with condensing unit with refrigeration compressors, motors, fans, condenser coils, electronic expansion valve, solenoid valves, 4 way valve, distribution

headers, capillaries, filters, shut down valves, service ports, receivers and accumulators and all other components which are essential for safe and satisfactory operation. Safety Devices Provide the following safety devices as a part of the outdoor unit: High pressure switch, fuses, crank case heater, fusible plug, over current protector. Selection Switches Fit the condensing unit printed circuit board (PCB) with selection switches for the length of pipe work, emergency operation switches and service mode switches, together with LED indications for operation / fault indication.

14.2.2 INDOOR UNITS

a) Ductable Type Indoor Unit

The IDU shall include pre filter, fan section & DX coil section. The unit shall be equipped with an electronic expansion valve, which can communicate with the VRF controller in the condensing unit. The housing of unit shall be light weight & powder coated galvanized steel. The unit shall have high static fan for Ductable arrangement. The address of the indoor unit shall be set automatically in case of individual and group control. In case of centralized control, it shall be set by liquid crystal display remote controller. The fan shall be dual suction, aerodynamically designed turbo, multi blade type, statically & dynamically balanced to ensure low noise and vibration free operation of the system. The fan shall be direct driven type, mounted directly on motor shaft having supported from housing. The cooling coil shall be made out of seamless copper tubes and have continuous aluminum fins. The fins shall be spaced by collars forming an integral part. The tubes shall be staggered in the direction of airflow. The tubes shall be hydraulically/ mechanically expanded for minimum thermal contact resistance with fins. Unit shall have cleanable type. The filter shall be easily serviceable. Each unit shall be provided with microprocessor thermostat for cooling or cooling and heating. Each unit shall be with wired LCD type remote controller. The remote controller shall memorize the latest malfunction code for easy maintenance. The controller shall be able to change fan speed and angle of swing flap individually as per requirement. The unit shall be supplied with Wireless remote.

b) REFRIGERANT PIPE WORK / REFNET JOINTS

Refrigerant Pipe work The scope of Refrigerant Piping work shall include Supply, installation, testing and commissioning all interconnecting pipe work between the condensing unit and the Indoor units. The refrigerant piping shall be out of hard / soft quality, pre-pressure tested, copper seamless pipe, of sizes as calculated to limit the pressure drop in the suction line and in the liquid line and hot gas line. The tenderer should ensure that the units are capable of delivering the rated capacity and meet the inside design conditions based on the locations of the indoor and outdoor units and also ensure that the air-conditioning units can perform, at the distances and elevation differences between the indoor and outdoor units. Refrigerant Copper piping shall be duly with insulated Nitrile Rubber Insulation (As per Specified with K Value of 0.027-0.029 K Cal/Hr. M Deg C at 0-16 Deg C) as follows

- 1/4 " (13mm thick Nitrile Rubber Insulation)

- 3/8" (13mm thick Nitrile Rubber Insulation)
- 1/2" (13mm thick Nitrile Rubber Insulation)
- 5/8" (13mm thick Nitrile Rubber Insulation)
- 3/4" (13mm thick Nitrile Rubber Insulation)
- 7/8" (13mm thick Nitrile Rubber Insulation)
- 1" (13mm thick Nitrile Rubber Insulation)
- 1 1/8" (19mm thick Nitrile Rubber Insulation)
- 1 1/4" (19mm thick Nitrile Rubber Insulation)
- 1 3/8" (19mm thick Nitrile Rubber Insulation)
- 1 1/2" (19mm thick Nitrile Rubber Insulation)
- 1 5/8" (19mm thick Nitrile Rubber Insulation)
- 1 3/4" (19mm thick Nitrile Rubber Insulation)
- 1 7/8" (19mm thick Nitrile Rubber Insulation)
- 2" (19mm thick Nitrile Rubber Insulation)

Refrigeration piping will have to be taken in the piping rack / Support individually connecting to all indoor units for the respective floors.

Refrigerant pipes should be supported on grooved wooden stripes suitable to accommodate the insulated refrigerant pipes. The piping should be clamped to these wooden strips using a „C" clamps. Necessary supports, fittings, valves & ref. joints where ever required will be included. The distance between two supports should not be more than 5 ft. wherever the pipes are running on the floor or exposed to view should be covered with 18 G GI tray/ plastic tray. The piping shall be refrigerant quality seamless copper tube with brazed connections and with the appropriate Distribution joints and headers. The piping should be routed at site in such a manner, that brazed joints in the Ref. Piping are kept to a minimum. During brazing, pass dry nitrogen through the pipe work. For outdoor piping, the pipes, after insulation, should be covered with Woven Glass Cloth 125 gsm finished in U/V Treated, pigmented Epoxy for Outdoor Piping, as per relevant code. All refrigerant pipes shall be insulated with tubular elastomeric nitrile rubber of adequate thickness as per manufactures standards or ASHARE Guidelines or as per specifications.

Cleanliness of piping: All pipe work must be kept clean and free from contamination to prevent breakdown of the system. Seal all pipe ends and keep sealed until immediately prior to making a joint.

Pressure Testing: The piping shall be vacuum dehydrated immediately after installation of pipe work and prior to sealing of insulation joints and start up of equipment & pressure tested to 3,800kPa; held for a minimum of 24 hours & checked for leaks and repaired if necessary. Following this, the pipe work to be vacuum dehydrated to (-755 mmHg) and held for one to four hours depending on the pipe length.

Fixing Pipe work: Pipes shall be layed on GI cable tray of adequate size wherever necessary as per site requirement and supports shall be fixed at minimum of 2 meter

centers with suitable saddling arrangement. Exposed Refrigerant pipes on the terrace shall be covered with openable GI Cable trays.

Joint Orientation: The scope of Refnet joints work shall include Supply, installation, testing and commissioning of refnet joints on refrigerant pipeline.

The Distribution refrigeration pipe joints and headers shall be located in an appropriate orientation to enable correct distribution of refrigerant. The Distribution Joints should be factory insulated with pre-formed sections of EPDM / Equivalent. All the refrigerant joints shall be proprietary in nature from the main VRV/VRF supplier. It should have one inlet and two outlet connections, both for suction and liquid line of respective size of the refrigerant piping along with its insulation. The refrigerant joint should be designed and supplied by the supplier of VRF indoor and outdoor unit manufacturer.

14.2.3 FALSE CEILING:

The existing false ceiling sheets along with supply/return air diffusers/grills shall be removed carefully without damaging grid work as directed by Site Engineer. All the area above the removed false ceiling shall be cleaned. The existing removed old false ceiling sheets, supply/return air diffusers/grills shall be kept in the hospital premises as directed by the hospital authority. The successful contractor shall replace the damaged sheets of the false ceiling by new sheets of size 600 mm X 600 mm, made up of medium density fiberboards of 12 mm thick, both sides laminated on the existing framework of aluminium tees suspended with M.S. Rods after carrying out ducting & insulation work wherever necessary. The opening for lighting /fan/air diffuser & grill arrangement shall be provided in the false ceiling as directed & if required. Before fixing the sheets the existing aluminium grid work shall be repaired, realigned. The damaged aluminium members of grid work shall be replaced & if required additional supports of 6 mm dia. ms rods suspended from ceiling to grid work shall be provided as per the direction of site engineer. All the suspended bars shall be painted with two coats of anticorrosive red oxide paint. The complete boxing shall be made airtight by using felt or pop to minimize the losses of conditioned air. Each Indoor unit shall be provided with a Wooden Trap door of required size for maintenance purpose in the false ceiling.

15 OPERATION AND MAINTENANCE

15.1 General

15.1.1 Reference:

A. Section 01000 applies to and governs the work of this Section.
B. Refer to Section – 01016 – Contract Closeout

15.1.2 Work Included:

A. Operate, maintain and monitor the pumping station including PLCs and SCADA systems, including it's piping and overflow for 36 months after successfully completing the commissioning and trial run. The scope of work includes but shall not be limited to the following:
    1. Contractor shall be responsible for overall operation and maintenance of complete pumping station including its piping, administration buildings, workshop, electrical rooms and other site works. O&M scope includes the existing plant and machineries also which are not replaced/retrofitted under the contract. The scope of O&M is comprehensive i.e.it includes spares and services of skilled & non-skilled staff along with necessary consumables and tools & material to execute O&M works.
    2. The Contractor shall be responsible for maintenance and all repairs of civil structures, equipment, plant machinery, piping, electrical, instrumentation and control systems.
    3. Ensure un-interrupted and trouble free operation of the pumping stations.
    4. Ensure proper operation of EOT cranes, other mechanical equipment, electrical and instrumentation appliances including PLCs & SCADA systems.
    5. Record and inform the Engineer of all overflow events from the pumping station.
    6. Record and inform the Engineer of all accidents.
    7. Prepare and implement, in consultation with the Engineer, an effective preventive maintenance programme for the pumping station, rising mains, bypasses and administration buildings.
    8. Be responsible for preventive maintenance including break-down maintenance.
    9. All incidental work connected to the regular operation and maintenance of the facilities.
    10. Be responsible for keeping updated records for equipment and maintaining every day logbook relating to running of machinery, consumption of energy and other consumables and various analyses performed and maintain the operation and maintenance data for the following:
        a) Daily status record of the pumping station, rising mains
        b) Daily flow record
        c) Operation records of mechanical screens
        d) Operation record of pumps
        e) Operation record of gates

f) Operation record of EOT
g) Maintenance record including consumables and spares used
h) Field mounted instrument readings
i) PLC and SCADA system records
j) CCTV records
k) Any other allied works required by Engineer

11. Data shall be made available for review as and when requested by the Engineer.

B. Submit a monthly report to the Engineer about the operation and maintenance of the facilities indicating the manpower, electric power and consumables, problems faced and rectified.
C. Maintain all pumping station units and other civil structures on the premises, including the boundary walls, in a sturdy manner.
D. Be responsible for proper upkeep of administrative and other buildings.
E. Be responsible for timely removal and safe disposal of the screenings and other garbage from the pumping station site, including transportation, loading and unloading. Obtain approval for the location of the disposal of the screenings from the Engineer.
F. Be responsible for maintenance of street lighting, terminal blocks, earthing, cabling etc.
G. Be responsible for the maintenance of the plants, land and landscaping on the sites.
H. Maintain the sewerage and drainage systems, roads and pathways in good condition within the pumping station premises.
I. Be responsible for the security of the premises.
J. Keep the sites including the administration buildings tidy and clean.
K. Hand over the pumping station, rising mains, administration building and site works to the Employer after expiry of the operation and maintenance part of the Contract in an acceptable operating condition.

15.1.3 <u>General Terms and Conditions:</u>

A. The Operation and Maintenance period shall be 36 months from the date of successful completion of trial run of the pumping station.
B. The Employer shall be responsible for paying the electricity bills during the O&M period. The Contractor shall be responsible for providing all consumables, lubricants and materials/tools required during the O & M period. All of these required during O&M period shall be stored by the contractor at his own cost to avoid unnecessary equipment downtime.
C. The Contractor shall be responsible for providing continuous staffing for operation, maintenance and monitoring of the pumping stations, rising mains, overflow, site works and administration buildings on each site.
D. The Contractor shall provide trouble-shooting services and emergency operation for the plant and equipment.
E. The Contractor shall take all necessary measures to avoid flooding of the pumping stations.

F. In the event of any damage, theft of property or injury or loss of life due to negligence on the part of Contractor, the Contractor shall be solely responsible and liable for compensation and damages.
G. Ensure that manufacturers / supplier's technical support shall be available within the time as specified by Engineer, during the O & M period.
H. The Contractor shall maintain security of the premises round-the-clock shall arrange manpower to prevent theft and malicious damage. No persons shall be allowed to enter the premises except municipal staff, officials and representatives of the Engineer without permission. Organised visits shall require written permission from the Engineer.
I. The Engineer shall have access to the sites at all times during the O & M period.
J. The Contractor shall observe all safety rules and regulations corresponding to electricity, factory act, fire safety rules and building codes and be responsible for all consequences and costs resulting from non-observance or oversight of the rules and regulations.

15.1.4 Financial Terms and Conditions:

A. Electricity charges for the operation of the pumping stations shall be borne by the Employer. The electricity shall be used only for the operation of the plant.
B. The cost of consumables, lubricants and materials/tools required during the O&M period will be borne by the Contractor.
C. The screenings from the sewage pumping stations shall be disposed to the land fill site designated by the Engineer.
D. All tools and equipment required for the proper operation and maintenance of the pumping station shall be provided by the Contractor.
E. All property and equipment in the premises shall be the property of Employer and shall not be rented, moved elsewhere or misused.

15.1.5 Deployment of Staff during Operation and Maintenance Period:

A. The Contractor shall provide the staffing to fully operate and maintain the pumping stations as per the specified qualifications stated below. The Contractor shall submit to the Engineer the list of staff to be employed with their detailed qualifications prior to the commencement of the Operation and Maintenance period.
B. During the O & M period and prior to handover of the facilities, the Contractor shall train the Employer's staff in all aspects of operation and maintenance of the pumping stations.
C. There shall be three shifts in a day.

Sr. No.	Post	Qualification Required	Total No. Required		Experience
1	Manager	Electrical / Mechanical	General shift	1	5 years in O&M of Pumping Station

Sr. No.	Post	Qualification Required	Total No. Required		Experience
		Graduate Engineer			
2	Engineer at Pumping station	Mechanical / Electrical Diploma Engineer	Three shift	3	3 years in O&M of pumping station with 1 year experience in HT system
3	Operators	ITI Certificate (Fitter or Electrician)	Three shift	3	3 years with 1 year experience in HT system
4	Maintenance unit	Tech. Skilled	Fitter and Electrician (general shift)	2	3 years
5	Helpers	Skilled	Three shift	3	1 year
6	Watchmen	Unskilled	Three shift	3	-
7	Labourers	Unskilled	Three shift	3	-
8	Sweepers and gardeners	Unskilled	General shift	1	-

D. The Contractor shall provide all uniforms, safety equipment and personal protection equipment to operating and maintenance staff.

15.1.6 Performance Tests:

A. Performance tests shall be carried out over a continuous 72-hour period in the last month of the O & M period. During the tests, each pump shall be operated at its design flow. All equipment will be operated in automatic mode. All mechanical and electrical equipment, instruments and SCADA systems etc shall be demonstrated to be in proper operating condition.
B. In the case of any interruptions, the tests will not be accepted and will be repeated. Prior to repetition of tests, the defects shall be rectified, so that all equipment/ systems are in good operating condition.

15.1.7 Training:

A. The Contractor shall carry out the training of Employer's Personnel in the operation and maintenance of the Works. The programme and scheduling of the training shall

be agreed with the Employer, and the Contractor shall provide experienced training staff, and all training materials. The Employer shall be responsible for nominating and selecting suitable personnel for training.

B. The Contractor shall provide instruction to the Employer's operating and maintenance staff in the proper operation and maintenance of the pumping station equipment and shall ensure that each major equipment supplier provides a minimum of two training sessions on their respective equipment. Training sessions shall be of the duration as specified in the individual equipment specifications.

15.1.8 Taking Over and Performance Certificates:

A. The conditions for issuing the certificates as detailed in the Conditions of Contract shall comprise:
   1. The Engineer shall issue a Completion Certificate after the successful completion of commissioning. This date of this certificate will constitute the start date of the 12-month operation & maintenance period and also the start date of the DLP of 36 months.
   2. The Taking-Over Certificate will be issued at the end of the O & M period, after operation & maintenance of the pumping station and the successful completion of a continuous 72-hour period to the satisfaction of Engineer. During this period the Employer's staff may be present at the pumping stations and will take over plant after the 72-hour operation.

15.1.9 Payment Terms:

The payment will be made on monthly basis against the O&M activities carried out by the Contractor after raising invoice and after deducting 10% from every interim certificate which will be paid after taking over of entire plant.

15.2 Products

A. Submit all required documents as specified above in this Section.
B. Documents as specified in Section 01016 are updated and have been submitted

15.3 Execution

Operate and maintain the systems for 36 months after successful commissioning and trail run of the pumping station

ELECTRICAL TECHNICAL SPECIFICATION

Table of Contents

1. General Electrical Specification

This Chapter details the general requirements of electrical works. Unless specified to the contrary in the Particular Requirements, Electricals supplied by the Contractor shall comply in all respects with these standards.

1.1 General

For uniformity of appearance all switchgear and control panels shall have a common appearance and colour.

In order to reduce the spares holding to a minimum, electrical components of a similar type and purpose shall be used throughout the Works.

Notwithstanding reference to zinc coated or plated hardware elsewhere in the specifications, all the hardware such as nuts and bolts shall be of stainless steel.

1.2 Abbreviations

Standard abbreviations of electrical terms have been used in this document. In case of doubt, the Tenderer shall get the same clarified from the Engineer's Representative.

1.3 General requirements for all electrical equipment such as HV & LV Switchgear and Control gear including Control Panels, Local Control Stations, Distribution Boards

1.3.1 Fabrication

Metal enclosure shall comprise rigid welded structural frame enclosed completely by metal sheets, minimum 2.0 mm thick, cold rolled cold annealed (CRCA) sheet steel, smooth finished, levelled and free from flaws for all doors, partitions and covers.

All sheet steelwork shall be phosphated in accordance with the following procedure and in accordance with relevant standards for phosphating iron and steel.

Oil, grease and dirt shall be thoroughly removed by emulsion cleaning.

Rust and scale shall be removed by pickling with dilute acid followed by washing with running water, rinsing with slightly alkaline hot water and drying.

After phosphating, thorough rinsing shall be carried out with clean water, followed by final rinsing with dilute dichromate solution and oven drying.

The phosphate coating shall be sealed by application of two coats of primer suitable for finishing by powder coating.

After application of the primer, the fabricated sheet steelwork shall be subject to epoxy based powder coating. Shade of powder coating is subject to approval by the Engineer's Representative.

The overall paint layer thickness shall be not less than 80 microns.

Each floor-mounted, free-standing panel if required shall be provided with its own base channel of at least 50 mm height, providing rigidity to the entire assembly. The base channel may be painted matt black.

Panel door shall be supported by strong hinges and braced in such a manner as to ensure freedom from sagging, bending and general distortion of panel or hinged parts.

All the hardware such as nuts and bolts shall be of stainless steel same shall be as per OEM standard ie Zinc passivated.

All doors, panels, removable covers shall be gasketed all around with neoprene gaskets. All louvers shall have screens and filters. Vent openings shall be covered by fine mesh on the vertical face. The screens and grills shall be made of either brass or galvanized iron wire mesh.

All the panel boards shall have cable entry from bottom. Separate removable gland plates with minimum thickness of 3 mm shall be provided for power and control cables. The gland plate for the power cables shall be of non-magnetic material.

Structure, buses and control wiring troughs shall be so designed and arranged as to make future extensions readily feasible.

Lifting lugs shall be provided for installation purposes.

1.3.2 Degree of Protection provided by the enclosure

a) MV (6.6 kV to 22 kV indoor switchgear)
   Protection against approach to live parts or contact with internal moving parts shall be not less than IP 4X.

b) LV (415 V switchgear, control panels, distribution boards, Local Control Stations etc)
   IP 54 – for equipment mounted indoors. In exceptional cases, where heat dissipation is an important consideration, degree of protection IP42 may be accepted by the Engineer's Representative. However, this will be on case-to-case basis.
   IP 55 – for equipment mounted outdoors. In addition, a canopy shall be provided for protection against direct rains.

c) For submersible equipment such as motors, the degree of protection shall be IP 68 minimum.

d) Electrical equipment proposed to be installed in hazardous (explosive) atmosphere shall be provided with enclosure appropriate for the application such as Group/Div. zone as applicable. This equipment shall be CMRS certified.

1.3.3 Safety Earthing

Assemblies shall be provided with earthing facilities as follows:

For single compartment assemblies an earth stud shall be provided.

For multi-compartment assemblies a clearly marked continuous earth bar of adequate size shall run the entire length of the assembly and shall be provided with facility for connection to Plant earthing system conductor.

The short-time rating of the earth busbar and connections shall be not less than that of the associated equipment or the maximum through-fault current of the power source. The temperature rise of the busbar and connections under fault conditions shall not cause damage to the connections of any equipment to which they may be connected.

No earth terminal bolts or studs shall be less than 8 mm diameter.

An earth bond of minimum size 2.5 mm2 copper shall be made to all enclosure doors where electrical supply has been taken.

1.3.4 Main Bus bars

Main bus bars shall be of electrolytic grade copper of high conductivity and non-segregated type.

Bus bars shall be located in air insulated enclosures and segregated from all other compartments of the cubicle.

Direct access or accidental contact with bus bars and primary connections shall not be possible. To provide a seal between adjacent cubicles, bus bars shall be taken through FRP seal-off barriers.

All bus bars joints shall be thoroughly cleaned and anti-oxide grease shall be applied. Plain and spring washers shall be provided to ensure good contacts at the joints and taps. Wherever aluminium to copper connections are required, suitable bimetallic connectors or clamps shall be used or copper shall be tinned to prevent electrolytic corrosion.

Bus bars shall be rated in accordance with the service conditions and the rated continuous and short time current ratings specified in the SLD drawing.

The bus-bars shall be designed considering the following criteria:

(a) Current density of 1.6A/Sq mm for copper.
(b) Sleeves made of insulating material on all bus bars.
(c) Bus bars carrying rated current continuously at Design Ambient Temperature shall be considered as 45ºC and temperature rise shall be considered as per latest relevant standard (IEC 61439) for LV switchgear and IEC 62271-1 (For MV switchgear).
(d) Configuration of bus bars and Proximity effect
(e) Bus bars shall withstand the short time rating of the panel

Bus bars shall be adequately supported on insulators, to withstand dynamic stresses due to short circuit current. Bus bar support insulators shall conform to relevant standards.

The material and spacing of the busbar support should be same as per the type tested assembly.

Neutral bus-bars of the panel boards shall be rated equal to the size of phase bus and shall be in same chamber with phase bus bar.

The bus bar clearances in air shall be suitable for the Basic Insulation Level (BIL) of the equipment and the bracing shall be suitable for electrodynamic forces during short circuit.

For MV (6.6kV– 22 kV) switchgear, bus bars shall be insulated by heat shrinkable type sleeving providing full insulation, with mould caps protecting all joints and for LV switchgear, bus bars shall be air insulated PVC sleeved.

1.3.5 Instrument Transformers

The CTs and VTs shall be of cast resin type (insulation Class 'E'), both for LV (415 V) and MV (6.6 kV to22 kV) and shall be able to withstand the thermal and mechanical stress resulting from the maximum short circuit and momentary current ratings of the switchgear. These shall be completely encapsulated.

i. Current Transformers

Current transformers shall comply with IS 2705 and shall be Cast resin dry type of wound-primary, bar-primary or window type according to ratio required and manufacturer's standard.

Current transformers for metering purpose shall have rated VA burden adequate for local as well as remote metering including lead burden where specified. For protection core, VA burden as recommended by the protective relay supplier shall be provided as a minimum.

Current transformers shall be of Class 0.5 accuracy for use with measuring instruments and Class 5P for use with protective relays. Rated secondary current of all current transformers shall be 5 A preferably.

Class 5P shall be used for combined overcurrent and earth fault protection of the inverse time overcurrent type. The Contractor shall ensure that the class and capacity of the current transformers is correct for the meter or relay being supplied. Separate current transformers/cores shall be used for metering & protection.

Class PS current transformers shall be used for special applications such as differential and REF protections. Parameters of such CTs shall be subject to Engineer's Representative approval. The Contractor shall furnish design check calculations for such applications. Each group of current transformers shall be earthed at one point via a removable test link.

The accuracy limit factor selected for current transformers shall take due account of the prospective short circuit current, connected burden and short time overload capability of the meters connected.

CTs shall have polarity marks indelibly marked on each transformer and at the associated terminal block. Facility shall be provided for short circuiting and earthing the CT secondary at the terminal blocks.

ii. Voltage / Potential Transformers

Voltage/ Potential transformers shall comply with IS 3156.

Secondary and tertiary windings of voltage transformers shall be rated for three phase line to line voltage of 110 V.

PT shall have ratios, outputs and accuracies as required.

The terminals of PT secondary and tertiary windings which are required to be connected to earth shall be earthed by an isolating link without a fuse.

Primary protection for high voltage windings shall be provided with current limiting fuses. All other windings of voltage transformers shall be provided with HRC fuses or MCBs.

1.3.6 Protective Relays

All protective relays shall be microprocessor based numerical type. The relays shall be provided with facilities for communication with/ setting from a PLC or SCADA system. Necessary testing facilities shall be provided for testing of the relays in-situ. The relays shall be provided with adequate number of potential-free output contacts for use in control circuit and spare contacts for Employer's use. The relays shall be provided with self-diagnostic feature and shall annunciate failure of the relay.

Relays shall comply with IS 3231.

The overcurrent relays shall be provided with Standard Inverse (SI), Normal Inverse (NI), Very

Inverse (VI) and Extremely Inverse (EI) characteristics according to IEC and shall be selectable for relay coordination.

All protective relays shall be enclosed in rectangular shaped, dust proof cases.

All relays shall be suitable for flush mounting. All protective relays shall be accessible for setting and resetting/programming from the front.

Access to setting/programming devices shall be possible only after the front covers of the relays are removed. Resetting facilities shall however be accessible external to the relay case. All protective relays shall be provided with positive action flag indicators or LEDs visible from the front.

Tripping relays shall be rated to operate satisfactorily between 50% and 110% of the rated voltage. Auxiliary relays shall be rated to operate satisfactorily between 70% and 110% of the rated voltage.

Auxiliary and tripping relays shall be electromechanical type, may be in fixed execution and with adequate number of output contacts.

1.3.7 Indicating and Integrating Meters

Digital meters shall be provided which shall be with 7-segment display. The meters shall have accuracy class of 1.0. Wherever Load Managers or Multi-function meters have been specified, they shall provide following minimum functions:

- All line currents
- All line and phase voltages
- Frequency
- Power Factor
- kW, kVA & kVAR
- kWh with Maximum Demand in kVA

They shall be provided with facilities for communication with PLC/SCADA system

1.3.8 Control, Indication, Protection and Annunciation devices used in Switchgear & Control gear

Instruments shall not be positioned above 2000 mm or below 500 mm and devices for isolation and switching shall be accessible within the zone 500 mm to 1800 mm above floor level. Control circuit devices and switching elements shall comply with latest version of IS/IEC 60947.

i. Control & Selector Switches

Control and instrument selector switches shall be heavy duty rotary type provided with escutcheon plates clearly marked to show operating position and suitable for semi-flush mounting with only switch front plate and operating handle projecting out.

Breaker control switches shall be pistol grip, black and selector switches shall be oval knob and black. Breaker control switches shall be three position spring return to neutral type.

Instrument selector switches shall be maintained stay-put type. Contacts of the switches shall be spring assisted and contact faces shall be with rivets of pure silver. The contact ratings shall be adequate to meet the requirements of circuit, in which they are used.

ii. Push Buttons

All push buttons shall have two normally open and two normally closed contacts, unless otherwise specified. The contacts shall be able to make and carry 5 A at 110V AC/DC

and shall be capable of breaking 1 A inductive load at 110V DC. They shall be provided with inscription plates engraved with their functions.

Colours of push buttons shall be as follows:

Stop, Emergency Stop	:	Red
Start	:	Green
Jogging/inching	:	Black
Reset (when not also acting as a stop)	:	Blue
Lamp test	:	Blue
Override/alarm accept	:	Yellow

Stop and Emergency Stop (lockable) push buttons shall be stay-put type, mushroom head, turn-to-release type, all other push buttons shall be spring return type.

iii. Indicating Lamps

Indicating lamps shall be panel-mounting type cluster LEDs. The wattage of lamps shall be 2.0 watts.

Lens colours shall comply with BS EN 60037 as follows:

Power On	:	Red
Running	:	Red
Stopped	:	Green
Tripped/alarm	:	Amber
Status	:	(open, closed etc) Blue (or Green for safe position & Red for unsafe position)
Ready to start	:	Blue
Warning (no imminent danger)	:	Amber

Note: *white may be used where doubt exists as to which other colour to use.

1.3.9 Auxiliary Supply Control

Provision shall be made for receiving, distributing, isolating and protection of auxiliary D.C. and A.C. supplies for controls, space heating etc. The fuse/MCB ratings shall be so chosen as to ensure selective clearance of sub circuit faults. Auxiliary bus wire of minimum as per current rating suitable wire size with calculation shall run throughout the

length of the switchgear for auxiliary supplies such as AC/DC control supply, space heating supply.

1.3.10 Miniature Circuit Breakers (MCBs)

Miniature circuit breakers shall comply with IS/IEC 60898. They shall be type C with a breaking capacity of at least 9 kA at 240/415 V. They shall be complete with Thermal Overload (O/L) and Short Circuit (S/C) protections. The operating knob of the MCB shall clearly indicate On, Off and Tripped positions. Miniature circuit breakers for DC circuits shall be suitable for DC application.

1.3.11 Residual Current Circuit Breakers

Residual current circuit breakers (RCCBs) or Residual current devices (RCDs) shall be current operated and comply with IS 12640. The tripping current shall be selected dependent on location within the supply network. It shall operate to trip all phases including the neutral.

1.3.12 Facia Annunciators

The alarm annunciation scheme, wherever specified, shall incorporate the following features :

- Suitable for operation on DC supply with a supply voltage variation between 80% and 110% of the rated voltage.

Window alarm annunciators shall incorporate the following constructional features :

- Facia annunciator system shall be static, microprocessor based
- Flush mounted facia units, each of which is provided with two lamps and a series resistor and a ground glass plate in front of the inscription. Facia window of minimum size 35 mm x 50 mm

The alarm annunciation scheme shall comprise the following equipment

- A facia unit for each fault
- Common alarm bell/hooter – preferably electronic type, separate for ‘Trip’ and ‘Non-Trip’ alarms with different tones, adjustable at site
- ‘Accept’ ‘Reset’ and ‘Lamp Test’ push buttons.

1.3.13 Panel Control Wiring

Switchgear shall be supplied completely wired internally up to equipment and terminal blocks and ready for external cable connections at the terminal blocks. Inter-panel wiring between cubicles of same switchgear shall be provided.

All panel Control wiring shall be done by 1.1kV grade HFFR/FRLS PVC insulated multi-stranded copper wire. CT circuit wiring shall be done with minimum 2.5 Sq.mm size

wire of above specification. Control and Potential circuits shall be wired with minimum 1.5 sq. mm size wires of above specifications. Wires shall be with suitable crimp able copper lugs.

Earth wires for meters, doors etc shall have a minimum cross-sectional area of 2.5 mm^2.

The wiring colour code shall be as follows

Phases - Red, Yellow, Blue

Neutral - Black

Control - Grey (DC), Black (AC)

Earth - Green/Yellow

1.3.14 Control Terminal Blocks

Control terminal blocks shall be of the screw clamp, rail mounted type to IS : 13947, VDE 0611 : Part 1 for connection of copper conductors up to 2 x 2.5 mm2 on either side and shall be 650V grade, 10 amps. rated.

Each terminal rail and each individual terminal shall be indelibly marked with a unique number corresponding to the schematic diagram terminal numbering system.

No more than two cables shall be terminated per clamp. Cross connections (shorting links) shall be used to link adjacent terminals where multiple wire connections are required. Earth terminals shall be coloured green/yellow and shall clamp to the fixing rail in order to provide earth continuity.

Terminals of different sizes and for different voltage terminations shall be partitioned. Terminal blocks for CTs and VTs shall be provided with test links and isolating & earthing facilities.

In any terminal arrangement, adequate space shall be provided for neat and logical termination of the incoming wiring. At least 20% spare terminals shall be provided, in addition to those used. In addition, terminal rails shall have provision for installation of at least 10% additional terminals.

Terminals within cubicles and enclosures shall not be obstructed and shall be easily accessible for installation and testing purposes, without removal of equipment.

1.3.15 Cable Termination Compartment

Necessary number of double compression cable glands shall be supplied for terminating power and control cables.

Glands shall be of heavy-duty brass, machine finished and complete with check nut, washers, neoprene compression ring, etc.

Cable lugs for all power and control cable connections shall be supplied. The lugs shall be tinned copper and of solder-less crimping type.

1.3.16 Miscellaneous Accessories for panels

The DC and AC auxiliary supplies shall be distributed inside the switchgear with necessary isolating arrangements at the point of entry and with sub-circuit MCBs as required.

Space heaters of adequate capacity shall be provided inside each panel to prevent moisture condensation within the enclosure. The space heater shall be suitable for 230V, 1 ph., 50 Hz supply and complete with MCB for isolation purpose and thermostat to cut off heater at pre-set temperature.

Each switchgear panel shall be provided with 230 Volts, 1 phase, 50 Hz, 5 amps. 3 pin receptacle with MCB located at a convenient position.

An 11 W CFL interior illuminating lamp together with operating door switch and protective fuse shall be provided for each panel at an appropriate location.

1.3.17 Labels and Nameplates

Each switchgear cubicle or feeder shall be fitted with a label in the front and rear of the cubicle. Each switchgear shall also be fitted with label indicating the switchgear designation, rating and duty.

Each relay, instrument, switch, fuse and other devices shall be provided with separate labels. Caution name plate, 'Caution Live Terminals' shall be provided at all points where the terminals are likely to remain live and isolation is possible only at remote end, i.e. incoming terminals of main isolators.

All door mounted equipment as well as equipment mounted inside the switchboard/panels shall be provided with individual labels with equipment designation/rating. Sizes of the labels and the inscribed label height shall be appropriate for the application.

Labels shall be made of non-rusting metal or engraved PVC and shall be fixed with countersunk screws. Paper stickers with stencilling shall not be used as labels.

2. Medium Voltage (MV) – 22 kV to 6.6 kV Metal-clad Switchgear

2.1 Applicable Standards

The switchgear and its components shall conform to the latest applicable standards specified below: In case of conflict between standards and this specification, this specification shall govern.

Code No.	Title
IEC 62271	High Voltage switchgear and Controlgear
IS 2705 /BS 7625	Current Transformers

IS 3156/BS 7625	Voltage Transformers
IS 2544 / BS 3297 / IEC 273	Busbar Support insulators
IEC 62271 /IS 13947 (Part 1) / IEC 947-1 / BSEN 60529	Degree of Protection
IS 3231	Electrical Relays for Power system protection
IS 1248 / BS 89 / IEC 51	Electrical Indicating Instruments
IS 9385 / BS 2692 / IEC 282	High Voltage Fuses
IS 722, 8530 / BS 5685 / IEC 145, 211	AC Electricity Meters
IS 9920 / IEC 129, 265 & 298	Alternating current Switches for voltages above 1kV and less than 52kV
IS 13703 / BS 1362 / IEC 269	Low voltage fuses
IS 10118	Code of practice for selection, installation and maintenance of switchgear and control gear
IS13947/BSEN 60947/IEC 947	Control switches

2.2 Constructional Features

The metal-clad switchgear shall have separate compartments, according to definition in the Standards, for the following components:

- Each set of bus bars
- Current transformers
- Voltage transformers on incomer side
- Each main switching device
- Cable chambers suitable for heat shrinkable type cable termination
- Metering, control, indications, annunciations and relaying devices.

Switchgear shall comprise indoor, metal-clad, electrical draw out type Vacuum circuit breaker. The circuit breaker shall be fully horizontally draw out type. The circuit breaker shall have distinct ‘service’ and ‘test’ positions. In the ‘test’ position, the circuit breakers shall be capable of being tested for operation without energizing the power circuits. Adequate number of auxiliary contacts shall be provided for each of the ‘service’ and ‘test’ limit position switches.

The ‘test’ position should preferably be obtained without the need to disconnect normal control connections and use of extension cords for testing.

The switchgear shall fully house the breaker both in the ‘service’ position as well as in the ‘test’

Position.

MV switchgear panels shall be internal arc tested for 40 kA for 1 sec (A-FLR) with full exhaust duct as per the latest version of IEC 62271-200.

Each power compartment of the switchgear – bus, VCB, cable shall be equipped with Light /Photo sensors which are directly integrated to the main numerical protection relay which shall produce a high-speed trip output of less than 10 milliseconds.

The current transformers shall be mounted on the fixed portion of the switchgear and not on the breaker truck.

Instruments, relays and control devices shall be mounted flush on hinged door of the metering compartment located in the front portion of cubicle. All auxiliary relays not requiring manual resetting will be mounted inside the L.V. compartment.

Other constructional features for switchgear panels shall be in accordance with this volume.

2.2.1 Safety Interlocks

Switchgear shall be provided with following interlocks:

Circuit breaker cubicles shall be provided with safety shutters operated automatically by the movement of the circuit breaker carriage to cover the exposed live parts when the breaker movement of the circuit breaker carriage to cover the exposed live parts when the breaker is withdrawn.

It shall not be possible to rack-out/withdraw a ‘Closed’ breaker from ‘Service’ position to

- ‘Test’ position or rack-in a ‘Closed’ breaker from ‘Test’ position to ‘Service’ position.
- The breaker trolley/cassette shall be earthed firmly before the same gets into ‘Service’ position.

2.2.2 Fabrication

Fabrication of sheet steel work, sheet steel treatment and painting shall be in accordance with General Electrical Specifications of this volume.

2.2.3 Bus bars

Bus bars shall be in accordance with this volume.

2.3 Circuit Breakers

2.3.1 General

Circuit breakers shall be electrical draw out type VCB type. These shall conform to relevant standards specified. Circuit breakers shall comprise three separate identical single pole units operated through a common shaft by the operating mechanism.

Vacuum interrupter, numerical relay and VCB shall be of same make for better quality and healthy life of the switchgear.

Circuit breakers shall be suitable for switching duty of transformers whose capacities are furnished in the single line diagram.

Isolating plugs and sockets for power as well as control circuits shall be of robust design and fully self-aligning. Plugs and sockets for power circuits shall be silver faced and shall be insulated with PVC or other insulating material shrouds.

The vacuum circuit breakers controlling motors shall be complete with surge arrestors to provide protection against switching surges.

Breaker internal wiring up to the plug shall be similar for all breakers.

2.3.2 Operating Mechanism

Circuit breaker shall be power operated, by a motor charged spring operated mechanism. Main poles of the breakers shall be such that the maximum difference between instants of contacts touching during closing shall not exceed half cycle of rated frequency. Operating mechanism shall be provided with anti-pumping feature, electrically and mechanically. Electrical anti-pumping feature shall be obtained by means of an auxiliary relay.

Mechanism shall be such that failure of any auxiliary spring shall not prevent tripping and will not cause tripping or closing operation of the power operated closing devices. When the circuit breaker is already closed, failure of any auxiliary spring shall not cause damage to the circuit breaker or endanger the operator.

A mechanical indicator shall be provided to show ‘open’, ‘closed’, ‘service’ and ‘test’ positions of breaker. It shall be located in a position where it will be visible to the operator standing on the front of the switchgear with cubicle door closed.

The closing coil shall operate correctly at all values of voltage between 85 % and 110 % of the rated voltage. A shunt trip shall operate correctly under all operating conditions of the circuit breaker up to the rated breaking capacity of the circuit breaker and all values of supply voltage between 70 % and 110 % of rated voltage.

Mechanical trip and close devices shall be provided for manual operation of the breaker. Access to mechanical closing device shall be secured by suitable shrouding or shall be accessible only after opening the cubicle door. However, the mechanical trip device shall be brought out to the front of the cubicle door.

Auxiliary switches mounted on the fixed portion of the cubicles and directly operated from the breaker operating mechanism on each breaker having 2 'NO' and 2 'NC' potential-free contacts rated for 10 amps. 240V AC and 1.0 amp (inductive breaking) 110 V DC shall be provided.

These contacts shall be in addition to those utilised in the control circuit of each breaker and shall be exclusively meant for the Purchaser's use in external interlocks and controls, indications/SCADA system.

2.3.3 Spring Operated Mechanism

Spring operated mechanism, shall be complete with motor, opening spring, closing spring with limit switch for automatic charging and all necessary accessories to make the mechanism a complete operating unit.

As long as power is available to the motor, a continuous sequence of closing and opening operations shall be possible. After failure of power supply to the motor, at least one open close-open operation of the circuit breaker shall be possible.

Breaker operation shall be independent of the motor which shall be used solely for compressing the closing spring.

Closing action of the circuit breaker shall compress the opening spring ready for tripping. When closing springs are discharged, after closing a breaker, closing springs shall automatically be charged for the next operation.

Motor shall be such that it requires less than 30 sec. for fully charging the closing spring. Motors shall be rated for 240V AC and shall operate satisfactorily at all values of voltage between 80 % and 110 % of rated voltage.

Mechanical indicators to indicate ‘charged’ and ‘discharged’ condition of spring shall be provided. It shall be possible to charge the spring manually in the event of non-availability of the spring

charging motor. Suitable spring charging handle shall be provided for this purpose.

The local electrical closing and tripping control shall be by a control switch mounted on the cubicle door.

The mechanical trip and close devices shall be provided on the breakers in addition to above.

2.4 Inspection and Testing

All Routine Tests according to latest IEC 62271-1/200/203/204/100 shall be carried out on completely assembled switchgear assembly at the manufacturer’s Works and the same shall be witnessed by Engineer’s Representative. The Engineer’s Representative shall also witness all the Routine and performance tests on the circuit breaker. In addition to these tests, the manufacturer of the equipment shall also carry out primary injection test for all current operated relays and meters. Routine Test Certificates of all major items such as circuit breakers, CTs, VTs, protective relays and meters shall also be furnished to the Employer.

Type test reports for the switchgear panel of similar rating for the following tests shall be submitted along Inspection call.(not older than 5 years).

3. 415 V SWITCHGEAR

3.1 Codes & Standards

The design, construction, manufacture and performance of equipment shall conform to latest applicable BIS/IEC standards and comply with all currently applicable statutes, regulations and safety codes in the locality where the equipment will be installed.

To ensure Safety of System & Operators, Factory built assemblies of switchgears should be as per latest standard of IEC 61439 – 1 & 2 totally type tested assemblies and Internal Arc compliance at all three locations viz, Horizontal Busbar, Vertical Busbar and Cable alley as per IEC 61641.

To ensure optimum protection and avoids unnecessary tripping, Switchgear Manufacturer shall ensure total discrimination between Upstream and Downstream Breakers (ACB, MCCB, MPCB and MCBs) from Main LV Panel, MCC to Final Distribution Board.

The relevant Indian & international Standards are :

Title	Code No.
Low Voltage switchgear and control gear assemblies	IEC 61439 – 1 & 2
Factory built assemblies of switchgear rand control gear for voltages upto and including 1000 V AC and 1200 V DC	BS5486/IEC61439-1&2
Air Circuit Breaker & Moulded Case Circuit Breakers	IEC 60947
Miniature Circuit Breakers	IS/IEC 60898
Low voltage Fuses	IS13703/BS1362/IEC269-1/ IEC 60947-3
Contactors	IS13947/BSEN 60947-4/IEC 60947- 4-1
Starters	IS13947/BSEN60947-4/IEC292-1 to 4/IEC60947-4-1
Control Switches / Push Buttons	IS6875/BSEN60947/ IEC60044
Current Transformers	IS2705/BS7626/ IEC 60044-1
Voltage Transformers	IS3156/BS7625/IEC60186
Indicating instruments	IS1248/BS89/IEC60051

Marking and arrangement of switchgear busbars	IS 375

A.C. Electricity Meters	IS722, 8530/BS5685 / IEC 145, 211
Degree of Protection	IS13947/IEC947-P1/BSEN 60529/ IEC 60529
Code of Practice for Selection, Installation and Maintenance of Switchgear and Control gear, Part I: General.	IS10118
Bus Bar	IS613
Relays	IS3231/IS3842/BSEN60947-5-1
Control Switches and Push Buttons	IS6875/BSEN60947/BSEN60037/IEC60037
Enclosed low voltage switchgear and controlgear assemblies Guide for testing under conditions of arcing due to internal fault	IEC 61641 – ed3

3.2 Features of Construction

The main 415V LV switchboard shall be designed and manufactured in accordance with IS 13947, IEC 61439 (Part I & II) and IEC 60947. All the metering devices, protection devices, switching devices etc. shall be suitable for communication with SCADA system.

The switchgear shall be metal enclosed, modular type suitable for indoor, floor mounting and shall have following features:

- Height shall not exceed 2475 mm (with base frame)
- Shall be Single or double front execution and fixed or draw out type as specified in Particular Technical Specifications.
- Shall be provided with proper gasketing for removable covers, doors, between panels and
  base frame and all around the perimeter of adjacent panels to achieve required degree of
  protection.
- Design of LV switchgear shall conform to Form 4a – fully compartmentalised execution. The switchgear shall be divided into distinct vertical sections each comprising :
- A completely metal enclosed bus bar compartment running horizontally.
- Individual feeder modules arranged in multi-tier formation. It is essential that the modules
  are integral multiples of the basic unit size to provide for flexibility in changes, if any, at site. Enclosed vertical busbars serving all modules in the vertical section. For safety isolation of the vertical bus bars, insulating barrier with cut-outs shall be provided to allow the power stab contacts to engage with vertical bus bars.

- A vertical cable alley covering the entire height. The cable alley width shall have minimum width of 300mm.
- A horizontal separate enclosure for all auxiliary power & control buses, as required, shall be located so as to enable easy identification, maintenance and segregation from the main

  power buses. Tap – off connections from these buses shall be arranged separately for each vertical section.

  The Switchgear shall be easily extendable on both sides by the addition of vertical sections

  after removing the end covers.

  Operating devices shall be incorporated only in the front of switchgear.

3.3 Withdrawable Components

Where removable or withdrawable components are specified they shall offer the drawer status change in shortest time possible, where appropriate, be provided with distinct locations for 'test/Connected or Disconnected"' and 'removed' position. The drawers shall provide the facility to be locked by 3 padlocks to prevent unauthorized insertion/withdrawal and OPEN / CLOSE operation of circuit breaker. Withdrawable parts shall not be withdrawn or re-inserted unless the main circuit has been interrupted. No dedicated tool shall be required to move the mobile part from a position to another one. Operating handle/tool on drawers shall be rejected.

The degree of protection applying to the connected position shall be maintained in the 'test' and 'disconnected' position and during transfer from one position to another.

Withdrawable parts shall be fitted with positive guides to ensure correct alignment of the isolating contacts in whichever position is selected.

Breaker should have inbuilt communication Ports for communication of trip unit data, breaker (ON/OFF/Trip/Ready to Close) & Cradle position (Connected, Test & Disconnected). Breaker shall provide at least last 30 trip and event history with date and time stamping

3.4 Main Buses

Main bus bars shall be provided in accordance with this volume.

3.5 Auxiliary Buses

Auxiliary buses for control power supply, space heater power supply or any other specified service shall be provided. These buses shall be insulated, adequately supported and sized to suit specified requirements. The material of control power supply buses shall be electrolytic

copper.

3.6 Sheet Metal Work

Fabrication and painting (sheet metal work) shall be in accordance with this volume.

3.7 Air Circuit Breakers

Air circuit breakers shall comply with BS EN 60947-2 or IEC 60947-2 and shall be suitable for breaking capacity of 50 kA for 1sec.

Circuit breakers shall be Electrical Draw out type. The draw out operation shall be possible through a closed door.

Circuit breakers should be individually housed in sheet metal cassettes provided with hinged doors.

The breaker shall have three distinct positions within the cassette as follows :

Service Position	:	With main and auxiliary contact connected.
Test Position	:	With power contacts fully disconnected and control circuit contacts connected.
Isolated Position	:	With both power and control circuit contacts fully disconnected.

Mechanically operated targets to show 'Open', 'Closed', 'Service' and 'Test' positions of the circuit breaker. Padlock devices shall be provided in order to control opening/closing and racking in/out of the circuit breaker

Mechanically operated, red 'trip' push button, shrouded to prevent accidental operation. Circuit breaker main contacts should be separate from arcing contacts

Locking facilities in the 'Service', 'Test', and 'Isolated', positions. In test position the breaker will be tested without energizing the power circuits. The breaker shall remain fully housed inside the compartment in the test position. Complete operation of the circuit breaker and trip unit must be accessible without opening the circuit breaker door

Closing and trip coil shall operate satisfactorily under the following conditions of supply voltage variation:

• Closing coils - 85% to 110% of rated voltage.

• Trip coils - 70% to 110% of rated voltage

Following indicating lamps for ACBs shall be considered:

(a) On

(b) Off

(c) Trip

(d) Test Position

(e) Service Position

(f) Spring Charged

(g) Trip Circuit healthy

(h) Control Supply Healthy

R, Y, B indication lamps, Lamp test push button, Emergency trip push button shall be considered at incomers.

Trip shall be independent of local/remote. Emergency trip push button shall be mushroom type with lockable key.

When series trip circuit breakers are specified the following microprocessor releases with adjustable settings shall be provided:

(a) Overload

(b) Short circuit

(c) Under voltage

(d) Earth Fault

The breakers controlling motors shall operate satisfactorily under following conditions:

(a) Direct-on-line starting of the specified motor.

(b) Breaking no load current of the specified motor.

Auxiliary switches directly operated by the breaker operating mechanism and having 4 NO and 4 NC contacts shall be provided on each breaker for test and service position. The auxiliary switch contacts shall have a minimum rated thermal current of 10 Amp.

Spring operated mechanisms shall be provided with volt-free contacts to give indication that the springs are charged.

Each incomer shall be provided with a Multi Function Meter displaying all electrical parameters like (but not limited to) current, voltage, kW, kVA, KVAr, kWH, MD, PF, Hz, etc. and shall have provision for remote communication with SCADA/ PLC.

The switchgear shall be complete with all equipment such as CT, VT, switches etc. duly wired up to terminal blocks. Terminal blocks shall be located at suitable place for easy access. CT shorting, isolating terminals shall be provided for CTs and isolating terminals shall be provided for VT connections. Twenty (20) percent spare terminals shall be provided in each cubicle. Ring type lugs suitable for termination of 2.5 sq mm copper wires shall be used.

3.7.1 Interlocks and Test Operation Facilities

All EDO type ACBs shall indicate Ready-to-Close status of breaker (mechanically on front of ACB or electrical indication lamp of panel front door), after checking all the given conditions (UV release energized, Shunt release de-energized, spring charged, Breaker is not "ON", Breaker has not tripped on fault, Breaker is not mechanically interlocked with other breaker and ACB is not racked in completely in service position) ensuring safety for user and electrical distribution. .

3.8 Moulded Case Circuit Breakers

Moulded case circuit breakers (MCCBs) shall be provided for use in lieu of switch fuse for the motor controls for higher kW ratings where MPCBs are not available. Moulded case circuit breakers shall comply with relevant IEC 61439 or IS/ BS EN 60947-2 .All MCCBs shall be rated for 415V, 3 Ph, 50Hz.

MCCBs in AC circuits shall be of triple/four pole construction arranged for simultaneous three/four pole manual closing and opening and for automatic instantaneous tripping on short circuit.

All the MCCBs shall be of current limiting type and shall provide a cut off in, < 10 ms for prospective currents during faults.

Operating mechanism shall be quick-make, quick-break and trip-free type. The ON, OFF and TRIP positions of the MCCB shall be clearly indicated and visible to the operator. All MCCBs shall be provided with rotary operating handle with door interlock feature. All MCCB feeders shall be provided with ON/OFF/TRIP indicating lamps through auxiliary contacts. All MCCB's shall be with Icu=Ics=100%. The MCCB's shall be provided with thermal magnetic based overload, short circuit and earth fault releases

All MCCBs shall be provided with 2 NO + 2 NC aux. contacts exclusively for Purchaser's use or as specified in Data Sheet.

MCCB terminals shall be shrouded and designed to receive cable lugs for cable sizes relevant to circuit rating.

All MCCBs shall have electric fault trip indication on panel.

MCCB up to 250A shall be Thermal magnetic type & above 250A should be Microprocessor type.

3.9 Motor Protection Circuit Breakers (MPCBs)

MPCBs shall be 3 phase devices suitable for direct connection to system having fault level of 50 kA r.m.s. MPCBs shall be complete with in-built bi-metal overload protection, short circuit protection and protection against single phasing.

Bi-metal overload protection shall have range suitable for motor F.L.C. These shall be class 10 (normal duty) for normal applications such as pumps, agitators etc. and class 20 (heavy duty) for long time starting equipment such as centrifugal blowers.

The protections shall provide at least 1 no. potential free output alarm contact for use in control circuitry, alarm and signal to SCADA system.

Operating mechanism shall be quick-make, quick-break and trip-free type. The operating knob/handle shall have three positive positions `ON', `OFF' and `TRIP' and the same shall provide door interlocking facility with a defeat feature.

3.10 Contactors

Contactors shall comply with IS 13947 or BS EN60947 or IEC 60947. They shall be maintenance free and where possible allow replacement of the coil, without disturbance to the wiring. Contactors shall be provided for AC3 utilisation category. Contactor rating shall provide a minimum margin of 20% over the actual full load current notwithstanding the general recommendations of the switchgear supplier.

The switchgear – fuses, contactors, overload relays – shall provide type 2 coordination.

The contactors shall have adequate number of auxiliary contacts for use in control circuit, local indication as well as remote indication on SCADA. The contactors shall not drop even when the coil voltage drops to 70% of rated voltage

3.11 Thermal Overload Relays

The thermal overload relay shall be individual mounted, CT operated continuously adjustable with built-in single phasing preventer type. The overload relay shall be three element positive acting ambient temperature compensated having self / hand resetting arrangement. Relay shall be wired upto terminals through an auxiliary contactor to provide remote trip indication.

MPR (motor protection relay) shall offer advanced motor protections Overload (definite time / inverse) , Over current, Under current, Phase loss, Phase reversal, Stall, Jam, Current Imbalance, Earth fault(optional) protections.

3.12 Motor Starters

The selection of starters shall be made according to the rating of the motor used with the equipment. Starter components shall be selected as per Type 2 coordination defined by IEC 60947-4-1. The selection shall be done as follows:

Up to & including 5.5 kW	:	Direct On line Starter
Above 5.5 kW up to & including 75 kW	:	Star-Delta Starter
Above 75 kW	:	Soft Starters/VFD

At least 20% spare shall be considered for power feeders and DOL starter feeders. VFD and soft starter need not to be considered in spares as standby unit will be available as per process requirement

All the motor starters including VFDs shall be wired to communicate with PLC and SCADA system as well as local control station. s

3.12.1 Starter design

The LV Switchgear shall be “fuse-less” type. i.e. Motor Protection Circuit Breakers (MPCBs) and Moulded Case Circuit Breakers (MCCBs) shall be provided in place of switch-fuse and fuse-switch combination.

The utilisation category of the starter shall be AC 3 and the duty class coordination shall be Type 2 as defined by IEC 61439 or IS 13947 or BS EN 60947-4-1.

i. Direct on-line starters (DOL)

Direct on-line starters shall be suitable for Class AC 3 utilization category suitable for type –2 coordination as specified in applicable standards. Each DOL starter feeder shall be complete with Motor Protection Circuit Breaker (MPCB) with built in overload relay and single phasing preventor, contactor, ON-OFF-TRIP indication lamps, Start-Stop-Reset push button.

ii. Star-Delta Starters

Automatic star-Delta starters shall comprise three sets of contactors one for the line, one for the star point and one for the delta, and a timer relay to automatically change the connections from star to delta.

Star-delta contactors shall be electrically interlocked to permit starting of the motor in the proper sequence.

Start delta starters shall be suitable for Class AC 3 utilisation category suitable for type-2 coordination as specified in applicable standards.

Each starter feeder shall be complete with MPCB/MCCB as appropriate with built in overload relay and single phasing preventor,3 nos. contactors, ON-OFF-TRIP indication lamps, Start-+Stop-Reset push button.

iii. Reversing starters

Reversing starters shall comprise forward and reverse contactors, electrically interlocked with each other.

Reversing starters shall be suitable for Class AC 4 duty.

3.13 Interface with PLC/SCADA system

The PCC & MCCs shall be wired for interface with PLC and SCADA systems. For this purpose, Digital Inputs (DI), Digital Outputs (DO), Analogue Inputs (AI), Analogue Outputs (AO) as applicable for individual starters shall be wired to a common Marshalling compartment in the respective PCC and MCCs. 1 no. marshalling compartment shall be provided for each transport section of the PCC and MCCs. Terminal blocks for High Level signals and Low Level signals shall be segregated for ease of cabling. Multi-core cables shall be run from these marshalling compartments to the PLC and SCADA system.

3.14 Control Transformer

Each Bus section in the MCC shall be provided with a control transformer 415/110V, single phase, dry type and of adequate VA rating to cater to loads of control circuitry of the feeders connected to that bus. The transformers shall be adequately protected on the primary side by an MCCB and on the secondary side by an MCB.

The secondary of the control transformer shall be taken to a control bus to be run throughout the length of the MCC.

3.15 Instrument Transformers

Instrument transformers shall be provided in accordance with General Electrical Specification of this volume.

3.16 Indicating and Integrating meters

These shall be in accordance with General Electrical Specification of this volume.

3.17 Inspection and Testing

All Routine Tests according to latest IS/IEC standards shall be carried out on completely assembled switchgear assembly at the manufacturer's Works and the same shall be witnessed by the Employer's Representative.

Routine Test Certificates of all major items such as circuit breakers, CTs, VTs, protective relays and meters shall also be furnished to the Employer.

Type test reports for the switchgear panel of similar rating for the following tests shall be submitted along Inspection call.(not older than 5 years).

3.18 Push button

Push button shall be in accordance with General Electrical Specification of this volume.

3.19 APFC Panel

3.19.1 Codes and Standards

Title	Code No.
Shunt capacitors for AC power systems	IS : 13585 / IS 2834
Automatic power factor correction (APFC) panels for voltage rating up to and including 1000V	IS 16636
Internal fuses and internal overpressure disconnectors for shunt capacitors	IS : 12672
Metal enclosed switchgear	IEC 61439
Control transformers for switchgear and control gear voltage not exceeding 1000V AC	IS12021
Current limiting Reactors	IS 5553

3.19.2 General

The equipment shall be complete with all necessary accessories and components as required as per applicable IS standard.

Supply, installation, Testing and Commissioning of automatic power factor improvement (indoor) with Capacitor Banks (APP Type), type test according to IEC 61439-1&2,IEC 61921 including interconnection with LT panel with appropriate size of electric cable. The panel shall be indoor, factory fabricated, dust and vermin proof (IP 42) type, suitable for 1100 V grade 3 phase 50 Hz AC supply, floor mounted in 12 stage with micro processor along with fully ventilated both side opening.

3.19.3 Design Features

- Panel constructional features shall be as per General Electrical Specification as mentioned in this volume.
- The capacitor banks shall be complete with all parts that are necessary or essential for efficient operation. Such parts shall be deemed to be within the scope of supply whether specifically mentioned or not.
- The capacitor bank may comprise of suitable number of single phase units in series parallel combination. However, the number of parallel units in each of the series racks shall be such that failure of one unit shall not create an overvoltage on the units in parallel with it, which will result in the failure of the parallel units.
- The complete capacitor banks with its accessories shall be metal enclosed (in sheet steel cubicle), indoor floor mounting and free standing type.
- All sheet steel work shall be thoroughly cleaned of rust, scale, oil, grease, dirt and swarf by pickling, emulsion cleaning etc. The sheet steel shall be phosphate and then painted with two coats of zinc rich primer paint. After application of primer, two coats of finishing synthetic enamel paint oven baked/stove shall be applied.
- The assembly of the banks shall be such that it provides sufficient ventilation for each unit. Necessary louvers may be provided in the cubicle to ensure proper ventilation.
- Each capacitor unit/bank shall be fitted with directly connected continuously rated, low loss discharge device to discharge the capacitors to reduce the voltage to 50 volts within one minute in accordance with the provisions of the latest edition of IS : 13585 / IS 2834
- All panels of capacitor banks with MCCBs, Contactor, minimum 8 stage automatic power factor correction relay enclosed in IP 42 compliant CRCA Sheet Steel enclosure.
- Capacitors shall be double layer All poly Polypropylene (APP) type having following specifications and conform to IS : 13585 / IS 2834.
- The capacitors shall have Low Dielectric Loss of 0.5 W/ kVAR.
- All capacitors shall be provided with 7% de-tuned filter along with all accessories and protections.

- Any change in rated voltage level of the capacitor bank due to the filter or otherwise shall be considered by the Contractor. The indicated rating of capacitor banks are at rated voltage of 415V.
- The banks shall be switched ON and OFF in both Auto as well as Manual mode. An “Auto/Manual” Switch at the incomer feeder shall be provided.
- All necessary auxiliary contactors of suitable duty along with feeder accessories are included in scope. All power Contactors for capacitor switching shall be of required duty.
- Manual operation shall be done with recess type panel mounted ON/OFF pushbutton with delay timer.
- Minimum current rating under site conditions, of circuit breakers, Contactors, and cables shall be at least 150% of rated capacitor current.
- Capacitors shall be mounted in such a way that heat dissipation is proper and the capacitors are accessible for maintenance and inspections.
- Capacitor switching and automatic power factor correction panel shall be designed in such a way that power factor of 0.995 lagging shall always be maintained. Timings to cut in capacitors shall be provided in such a manner to facilitate capacitor discharging before next switching and shall also avoid hunting due to temporary fluctuations of load. The timer shall be provided in both auto and manual mode.
- The Automatic power factor correction panel and capacitor panel are integral type, prewired including power connections. Due consideration shall be given for adding/ removal of capacitor or other components and maintenance considerations.
- Capacitor switching duty Contactor with 2 NO+2NC contacts, shall be provided for capacitor feeders.
- Each unit shall satisfactorily operate at 130% of rated KVAR including factors of overvoltage, harmonic currents and manufacturing tolerance. The units shall be capable of continuously withstanding satisfactorily any overvoltage up to a maximum of 10% above the rated voltage, excluding transients.
- Capacitor Panel shall be Type tested as per IS 16636.
- Each capacitor case and panel shall be earthed to a separate earth bus.

3.19.4 Unit Protection

Each capacitor unit shall be individually protected by a MCCB Breaker suitably rated for load current and short circuit capacity, so that a faulty capacitor unit shall be disconnected by the breaker without causing the bank to be disconnected. Thus, the breaker shall disconnect only the faulty unit and shall leave the rest of the units undisturbed.

The Inputs to the APFC system is Voltage input from two phases and current input from the third phase. Out of two phases of voltage one phase voltage is taken as Reference 0 and other phase voltage as 440 V. APFC need to be installed CT (Current Transformer) on the third phase at main incomer ACB after transformer, which will give signal to the APFC Relay. Based on this inputs the ASIC (Application Specific Integrated Circuit) OR Call it as Microprocessor internal to the APFC Relay will give output signal to relay outputs which will energize coil of the contactor so that the contactor come in line connecting the capacitor bank in circuit. However, this is step correction means PF is corrected in steps. The Voltage rise due to connection of capacitor banks is marginal. There will be no frequency correction with APFC System.

3.19.5 APFC Panel Accessories

- Power capacitor shall be housed in the lower/rear compartment and capacitor controls in the top/front compartment.
- Bus bars shall be of Copper conductor and high conductivity.
- Sequencing devices, timer and auxiliary relays for automatic sequential switching of the capacitors in and out of circuit.
- Auto-Manual selector switches
- Microprocessor based Automatic Power Factor Correction (APFC) Relay
- Push buttons for switching ‘On’ and ‘Off’ of individual capacitor units in manual mode.
- Red and green lamps for capacitors ON/OFF indication.
- Protective numerical relays to protect the healthy capacitor units when one unit fails in a series connection
- Space heater and cubicle lighting as per the requirements

3.19.6 Tests and Test Reports

All tests shall be conducted in accordance with the latest edition of IS : 13585 / IS 2834 and as applicable for the controls. Type test certificates for similar capacitor units shall be furnished.

3.20 Local Push Button Stations

3.20.1 Standards

The design, manufacture and performance of the equipment to be supplied under the scope of this specification shall comply with latest revisions of relevant Indian Standards and rules. The design and workmanship shall be in accordance with best engineering practices as applicable to industrial electrical equipment enclosures.

3.20.2 Construction

Industrial Local Control Station enclosure shall be of Cast Aluminium LM6 alloy enclosure having minimum thickness as per OEM type tested design

The enclosure shall be weatherproof, suitable for outdoor installation. All mating surfaces of industrial LCS shall be with continuous non-deteriorating type special rubber gaskets/neoprene gaskets. An additional 2 mm thick Aluminium canopy shall be provided to give adequate protection against direct rains and sunlight.

For ease in cable terminations, the minimum distance between the terminal blocks and the cable entry gland plate shall be 50 mm for 1.5 sq. mm, size cable.

For HT Motor :

Only "START / EMERGENCY STOP" shall be provided.

Local Push Button Stations shall be metal enclosed, weather-proof, dust and vermin-proof, suitable for mounting on wall or steel structures. The enclosure shall be die-cast aluminium or sheet steel of 2 mm thickness and provide a degree of protection of not less than IP55 (IP-65 or IP-66 in case of Flame proof push button station). The enclosure shall be painted with one coat of epoxy primer and two coats of light grey epoxy paint.

The push button stations shall be complete with inscription plates, earthing terminals, gland plates and cable glands.

Push button shall be in accordance with General Electrical Specification of this volume.

3.20.3 Earthing

The enclosure shall be provided with two (2) nos. of external earthing terminals and one (1) no. internal earthing terminal each of 2.5 mm diameter complete with nut, spring washers for termination of 8 SWG G.I. wire.

3.20.4 Selector Switches

Local-Remote, Auto-Manual selector switches, where required to be provided on the Local Control Station, shall be in accordance with this volume.

4. Oil Type Transformers

4.1 Scope

The scope of this specification covers the design, manufacture, supply, testing, packing forwarding and delivery to erection site, installation, testing and commissioning for two winding, three phase, 50 Hz, outdoor type, distribution transformer of * kVA, 22/0.433kV, ONAN cooled, connected in Dyn11 with OCTC on HV winding and two winding, three phase, 50 Hz, outdoor type, Power transformer of * MVA, 22/6.6kV, ONAN cooled, connected in Dyn11 with OLTC on HV winding.

4.2 Codes and Standards

The supply, installation, testing and commissioning of transformers and accessories shall comply with the latest applicable standards and codes of practices. The equipment shall also conform to the latest applicable standards and codes of practice specified as under.

IS 1180-2014	Outdoor Type Oil Immersed Distribution Transformers up to & including 2500 kVA, 22 kV
IS 335	Insulating Oil
IS 2026	Power Transformer - General
IS 2099	High Voltage porcelain bushing
IS:7421	Bushings for < 1000V, AC
IS 3202	Code of Practice for Climate Proofing
IS 3639	Power Transformer Fittings & Accessories
IS 6600	Guide for Loading of Oil Immersed Transformers
IS 3637	Buchholz Relay
IS 2026	Tests
IS 1271	Electrical insulation – thermal insulation a
IS 10028	Code of practice for selection, Installation & maintenance of transformer

4.3 General

Transformers shall comply with IS 1180-2014 & IS 2026 and other applicable standards as mentioned above. They shall be oil immersed, naturally cooled type classified ONAN. The distribution transformer shall be 22kV/.433kV, 3phase two winding , Dyn11, OCTC having tapping range from +5% to -10% in steps of 2.5% and power transformer shall be 22kV/6.6kV, 3phase two winding , Dyn11, OLTC having tapping range from +5% to -10% in steps of 2.5%.

% Impedance shall be as per IS 1180-2014/ IS 2026 (Part-1).

The Distribution transformers shall be Energy Efficient Level 3 with maximum losses at 50% load and at 100% load as defined in IS 1180-2014.

The values of Load- losses and No-load losses shall be as given in IS 1180-2014.

The transformer shall be sized for continuous operation at its maximum rating under the climatic conditions defined in the Employer's Requirements. The rating shall allow for open, un-shaded operation.

Ambient temperature of 50ºC shall be considered for transformer design. Temperature rise shall be 40ºC for Oil temperature and 45ºC for winding temperature. Hot spot temperature limits shall be complying with IS 2026, IS 6600 & IEC 60076-2:1993 & it shall be limited to 98 Deg. C.

4.4 Constructional Features

4.4.1 General

The transformer tank shall be made from high grade plate steel, suitably reinforced by means of stiffeners made of structural steel sections. All seams, flanges, lifting lugs, braces and other parts attached to the tank shall be welded. The interior of the tank shall be cleaned by shot blasting and painted with two coats of heat resistant and oil insoluble paint.

Adequately sized manholes shall be provided for easy inspection and maintenance.

All joints which may have to be opened from time to time in the course of operation shall be of a design to permit them to be made easily oil tight in reassembly.

Lifting lugs and eyebolts shall be so located that a safe clearance is obtained between sling and transformer bushings, without the use of a spreader.

Transformer of rating above 500 KVA shall be equipped with detachable or separately mounted radiator banks. Transformers of rating 500 KVA and below shall be provided with fixed type radiators.

When transformers are provided with separately mounted radiators, flexible joints shall be provided on the main oil pipes connecting the transformer tank to the radiator banks to reduce vibration and facilitate erection and dismantling. The interconnecting pipes shall be provided with drain plug and air release vents.

4.4.2 Tank

Tank shall be made from good commercial grade low carbon steel and shall be of welded construction.

Tank shall be designed to permit lifting, by crane or jacks, of the complete transformer assembly filled with oil.

Tank shall be braced to withstand full vacuum and pressure test as specified by CBIP's (Central Board of Irrigation & Power) latest specification.

Suitable guides shall be provided in the tank for positioning the core and coil assembly. The core and coil assembly shall not be cover mounted.

Adequate space shall be provided at the bottom of the tank for collection of sediment.

The transformer base shall be designed to permit skidding of the complete transformer unit in any direction, when using plates or rails. The under-base shall be detachable unless transport facilities permit a fixed base.

The transformer top shall be provided with a detachable cover with a bolted flanged gasket joint. Lifting lugs shall be provided for removing the cover. The surface of the cover shall be suitably sloped so that it does not retain rain water. The material used for gaskets shall be rubberised cork.

4.4.3 Core

The magnetic circuit shall be of "core type" construction. The core shall be built out of high grade, non-ageing, low loss and high permeability cold rolled grain oriented silicon steel laminations adequately insulated, and joints mitred and interleaved to provide continuity of the magnetic circuit.

After being sheared the laminations shall be treated to remove all burrs. Both sides of the laminations and the cut edges shall be treated with appropriate insulation.

The finally assembled core shall be free from distortion. It shall be rigidly clamped to ensure adequate mechanical strength and to prevent vibrations during operation.

The core clamping structure shall be designed to minimise eddy current loss.

The core shall be provided with lugs suitable for lifting the complete core and coil assembly.

The core and coils assembly shall be so fixed in the tank that shifting will not occur during transport or short circuits.

All steel sections used for supporting the core shall be thoroughly sand-blasted, after cutting drilling and welding.

The operating flux density ‘B’ shall be so chosen that the core does not get into saturation at 110% of the rated voltage. The operating flux density shall be of the order of 1.65 to 1.7 Tesla.

Cross-sectional area for this purpose shall be adequate.

4.4.4 Windings

Windings shall be of electrolytic grade Copper of 99.9% purity.

Windings shall be subjected to a shrinking and seasoning process, so that no further shrinkage occurs during service. Adjustable devices shall be provided for taking up possible shrinkage in service.

Coils shall be supported at frequent intervals by means of wedge type insulation spacers permanently secured in place and arranged to ensure proper oil circulation. To ensure permanent tightness of winding assembly, the insulation spacers shall be dried and compressed at high pressure before use.

Windings shall not contain sharp bends which might damage the insulation or produce high dielectric stresses. No strip conductor wound on edge shall have width exceeding six times the thickness.

Materials used in the insulation and assembly of the windings shall be insoluble, non-catalytic and chemically inactive in the hot transformer oil and shall not soften or be otherwise affected under the operating conditions.

All threaded connections shall be locked. Leads from the winding to the terminal board and bushings shall be rigidly supported to prevent it from vibration. Guide tubes shall be used where practicable.

Windings and connections shall be braced to withstand shocks during transport or short circuits.

Coil clamping rings shall be of steel or of a suitable insulating material built from flat laminations.

The sequence and orientation of HV/LV side phase and neutral bushings shall be as specified in the latest edition of relevant IS.

Permanent current carrying joints in the windings and lead shall be brazed or soldered.

Clamping bolts for current carrying parts inside oil shall be made of oil resistant material which shall not be affected by acidity in the oil.

Terminals of all windings including unloaded stabilising windings shall be brought out of the tank through bushings for external connection.

Transformer shall operate without injurious heating at the rated KVA and at any voltage up to ± 10 % of the rated voltage of any tap. Transformer shall be designed for 110 % continuous over-fluxing withstands capability.

Vector group of winding connection shall be Dyn11

4.4.5 Bushings

a) All bushings shall conform to the requirements of latest revision of IS: 2099. The bushing ratings shall be commensurate with the transformer rating and shall not pose any limitations on transformer overload capacity. Impulse withstand levels shall be in accordance with the Standards mentioned and creepage distance shall be suitable for severely polluted atmosphere (minimum 31 mm/ kV).

b) All porcelain shall be sound, free from defects and thoroughly vitrified. The glaze shall not depend upon insulation, shall be smooth, hard, of uniform shade of brown and shall cover completely all exposed parts of insulator. Porcelain shall not engage directly with the hard metal and, where necessary, approved gasket shall be interposed between porcelain and fittings. All porcelain clamping surfaces in contact with gaskets shall be accurately ground and free from glaze.

c) Connection from the main winding to the bushing shall be flexible.

d) Clamps and fittings made of steel and malleable iron shall be galvanised.

e) Bolt threads shall be greased before erection

f) Each porcelain bushing shall have the manufacturer’s identification marks.

g) Bushing insulators are to be mounted on the tank in a manner such that the external connection can be taken away clear of all obstacles. Neutral bushing shall be mounted in a position from which a connection may be taken.

h) The bushing shall be so located as to provide minimum electrical clearances between phase to phase and also between phase and ground as per the IS 2099.

4.4.6 Oil

Transformer and associated oil filled equipment shall be supplied with first filling of oil plus 10% extra in non-returnable drums. The oil shall conform to IS: 335. No inhibitors shall be used in the oil.

4.4.7 Neutral Earthing

Neutral Grounding Resistor (NGR) shall be considered for connecting the secondary side neutral of the power transformer (above 5 MVA size) to the ground so as to obtain a resistance grounded system at the secondary side.

NGR shall comply to the specification as mentioned in this volume.

4.4.8 Cable Terminations

Cable termination boxes for ground-mounted transformers shall be suitable for dry termination of HV cables and LV cables. Non-magnetic gland plates shall be provided for the termination of single core cables.

LV neutral of distribution transformer shall be brought out through 1.1 kV rated bushing for forming 3 ph., 4 wire system.

An extra LV Neutral bushing shall be provided and shall be directly connected to earth by means of two nos. earthing conductors. Bushings rated above 1000 VAC shall comply with IS 2099.

It shall be possible to remove the cable boxes without dismantling the cable glanding or draining the oil.

4.4.9 Cable Box with Disconnecting Chambers

The cable boxes, wherever required as per the prescribed criteria, shall be complete with cable joint fittings or sealing ends as required, tinned copper lugs to suit specified cable, compound and all other accessories including compression type glands, armour earth clamps and body earth terminal.

For Cable type of terminations, disconnecting chamber shall be provided to enable the transformer to be removed without unsealing the cables or draining oil from the main tank. The disconnecting chamber shall be air insulated and complete with seal-off bushings, removable flexible connectors/ links and removable covers.

Cable boxes shall be designed to accommodate all cable joint fittings or sealing ends as required, including stress/ cones or other approved means for grading voltage stress on the terminal insulation of cables operating at voltages of 22 kV and above.

Phase to phase and phase to ground clearances within the chamber shall be such as to enable either the transformer or cable to be subjected separately to HV tests when filled with transformer oil. Phase to phase and phase to ground clearances with the cable box shall be as per CBIP. Insulating Fire resistant barriers should be provided between each phase of HV cable box.

4.4.10 Marshalling Box

i. Whenever fittings such as OTI/ WTI, temperature indicators with auxiliary contacts, Buchholz relay, bushing CTs etc. are provided the marshalling box shall be provided to marshal in it all the contacts/ terminals of electrical devices mounted on the transformer.
ii. It shall be in the Contractor's scope to provide interconnection cabling between the marshalling box and the accessory devices by either PVC insulated, FRLS wires in GI conduits and/ or XLPE insulated, inner & outer extruded PVC, armoured cable and necessary compression type brass cable glands at the marshalling box for the above mentioned cables as well as for terminating the incoming cables from remote panels.
iii. The marshalling box shall be tank mounted (at easily accessible location), outdoor type, IP 55 protected, weather-proof, sheet-steel (2 mm thick) enclosed, with hinged door having padlocking facility and painted as per paint shade approved by the Purchaser. All doors, covers and plates shall be fitted with Neoprene gaskets. Bottom shall be at least 600 mm from floor level and provided with gland plate and cable glands as required. Top surface shall be sloped.
iv. The marshalling box shall be provided with glass window so as to make the WTI and the OTI dials visible from the outside without opening the door.
v. All contacts for alarm, trip and indication circuits shall each be potential free, wired for auxiliary DC supply as specified and brought out to separate terminals at the terminal blocks in the marshalling-box. Terminals shall be rated for 10A. Wiring shall be 1.1 kV grade, with multi-stranded, copper conductors of sizes not smaller than 1.5 sq.mm for control and 2.5 sq. mm for CT circuits. CT terminals shall be provided with shorting facility and earthing.
vi. The marshalling box shall house the winding temperature indicator (WTI, 150 mm dial), the oil temperature indicator (OTI, 150 mm dial), terminal block, 60W anti-condensation heater, 5/15A industrial type five pin socket and a 10W CFL with fixture, suitable for operating on 240 V AC. Contacts of Buchholz relay, WTI, OTI, magnetic level gauge, PRD, OSR shall be wired up to the terminal block.

4.4.11 Valves

Valves shall be of Gun Metal material & of suitable diameter for their intended purpose. Following valves shall be provided for each oil immersed transformer.

i. One (1) top filter valve with blanking plate.
ii. One (1) bottom filter valve with blanking plate
iii. One (1) bottom sampling valve with blanking plate
iv. Two (2) Shut-Off / Gate Valve for OLTC Part of Conservator (on both sides of Oil Surge relay)
v. Two (2) Shut-Off / Gate Valve for Main Conservator(on both sides of Buchholz relay)
vi. One (1) Drain valve with blanking plate for Conservator
vii. One (1) bottom drain valve with blanking plate for complete Transformer
viii. One (1) top sampling valve with blanking plate
ix. Radiator shut off valves with blanking plates between radiator head & tank.
x. Oil filling valve with blanking plate for Main & OLTC conservator.

4.4.12 Transformer Cooling Equipment

Transformers of rating below 500 kVA shall be equipped with fixed type radiators and transformers of rating 500 kVA and above shall be provided with detachable or separately mounted radiator banks.

Tank mounted radiators shall be of the detachable type with bolted flanged connections. Sheet steel thickness for the radiators shall not be less than 1.2 mm. The following accessories shall be provided for each radiator:

- Shut off valves and blanking plates on transformer tank at each point of connection
- Top and bottom shut off valves and blanking plates on each radiator
- Lifting lugs.
- Top oil filling hole with cap.
- Air release plug at top.
- Oil drain plug at bottom

Radiators shall be designed to withstand the vacuum and pressure conditions specified for the tank. They shall be so designed as to avoid pockets in which moisture may collect, to completely drain oil into the tank and to prevent formation of gas pockets when the tank is being filled.

The clearance between all pipe work and live parts shall be more than the clearance for live parts to earth.

4.5 Noise Level

Noise level of transformers shall be as per latest NEMA standard.

4.6 Painting

Inside of transformer tank shall be painted with varnish or oil resistant paint. For external surfaces one coat of thermo setting powder paint or one coat of epoxy primer followed by two coats of polyurethane base paint shall be used.

Painting shall comply to applicable standard of IS 1180 / IS 2026.

4.7 Off Circuit Tap Changing Mechanism (OCTC)

Off Circuit Tap Changing Mechanism (OCTC) for Transformer <= 1000 KVA: OCTC shall be with + 5% to –10% taps in steps of 2.5 % on HV winding of transformer; It shall comprise:

i. Operating handle or wheel, accessible from ground level. Tap changer operating switch mounted on the top of the transformer tanks will not be acceptable
ii. Tap position indicator.
iii. Pad locking arrangement without interfering with visual tap position indicator shall be provided.
iv. The tap-changer connections and contacts shall be accessible through an excess hole having a bolted cover with gasket.

4.8 On Load Tap Changing Gear for Power Transformer (>1000kVA)

(a) The OLTC range shall be from +5% to -10% in steps of 2.5% on HV winding of transformer. The OLTC gear shall be designed to complete successfully tap changes for the maximum current to which transformer can be loaded i.e., 150% of the rated current. Devices shall be incorporated to prevent tap change when the through current is in excess of the safe current that the tap changer can handle. The OLTC gear shall withstand through fault currents without injury.

(b) When a tap change has been commenced it shall be completed independently of the operation of the control relays and switches. Necessary safeguard shall be provided to allow for failure of auxiliary power supply or any other contingency which may result in the tap changer movement not being completed once it is commenced.

(c) Oil in compartments which contain the making and breaking contacts of the OLTC shall not mix with oil in other compartments of the OLTC or with transformer oil.

Gases released from these compartments shall be conveyed by a pipe to a separate oil conservator or to a segregated compartment within the main transformer conservator. A Buchholz relay shall be installed in the above pipe. The conservator shall be provided with a prismatic oil level gauge.

(d) Oil, in compartments of OLTC which do not contain the make and break contacts, shall be maintained under conservator head by valved pipe connections. Any gas leaving these compartments, shall pass through the Buchholz relay before entering the conservator.

(e) Oil filled compartments shall be provided with filling plug, drain valve with plug, air release vent, oil sampling device, inspection opening with gasketed and bolted cover with lifting handles.

(f) OLTC shall be designed suitable for local manual as well as local electrical operation and Remote electrical operation including SCADA operation with provision of master follower scheme for parallel operation. The OLTC shall be housed in a separate tank so that oil of the OLTC chamber does not come in contact with the oil of main tank in any way. There shall be

separate conservator with the arrangement of having the dehydrating breather for OLTC tank.

(g) OLTC driving mechanism and its associated control equipment (Local) shall be mounted in an outdoor, weather-proof cabinet with IP 55 protection (along with canopy) which shall include :

(i) Driving motor (415V, 3-phase, 50 Hz. AC squirrel cage).

(ii) Motor starting contactor with thermal overload relays, isolating switch and HRC fuses/MCCBs.

(iii) Duplicate sources of power supply with automatic changeover from the running source to the standby source and vice versa.

(iv) Control switch : Raise/off/lower(spring return to normal type) or independent push buttons..

(v) Emergency 'OFF' push button (stay put type).

(vi) Remote/local selector switch (maintained contact type).

(vii) Mechanical tap position indicator showing rated tap voltage against each position and resettable maximum and minimum indicators.

(viii) Limit switches to prevent motor over-travel in either direction and final mechanical stops.

(ix) Brake or clutch to permit only one tap change at a time on manual operation.

(x) Emergency manual operating device (hand crank or hand wheel).

(xi) A five digit operation counter.

(xii) Electrically interlocked reversing contactors (preferably also mechanically interlocked).

(xiii) 240V, 50 Hz. AC space heater with thermostat and MCB.

(xiv) Interior lighting fixture with lamp door switch / ON-OFF switch and HRC fuses / MCB.

(xv) Gasketted and hinged door with locking arrangement.

(xvi) Terminal blocks, internal wiring, earthing terminals and cable glands for power and control cables.

(xvii) Necessary relays, contactors, current transformers etc.

(xviii) Transducers or any other appropriate device for remote tap position indication.

(g) Control Requirements for OLTC

(h) The following electrical control features shall be provided :

(i) Positive completion of load current transfer, once a tap change has been initiated, without stopping on any intermediate position, even in case of failure of external power supply.

(ii) Only one tap change from each tap change impulse even if the control switches or push button is maintained in the operated position.

(iii) Cut-off of electrical control when manual control is resorted to. Cut-off of a counter impulse for a reverse tap change until the mechanism comes to rest and resets the circuits for a fresh operation.

(iv) Cut-off of electrical control when it tends to operate the tap beyond its extreme position.

(i) Automatic Control of OLTC

Automatic OLTC control shall include the following items:

(i) Voltage setting device

(ii) Voltage sensing and voltage regulating devices.

(iii) Line drop compensator with adjustable R and X elements.

(iv) Timer 5-25 seconds for delaying the operation of the tap changer in the first step for every tap change operation.

(v) Adjustable dead band for voltage variation

(j) Alarms

The following alarms shall be provided:

i. A.C. supply failure
ii. Drive motor auto tripped
iii. Other protective purpose considered essential by the VENDOR
iv. Out of step operation when paralleled transformers supposed to operate
v. on the same tap are operating at different taps.
vi. Tap change delayed
vii. Tap change incomplete
viii. AVR failure (if AVR is specified)
ix. Transformer cooler fail (if specified)
x. For all the alarms specified above a “OLTC trouble” group alarm to be provided in DCS which is located in control room.

(k) OLTC Panel :

The OLTC remote control equipment shall be suitable for 415V supply and shall be housed in an indoor sheet steel cubicle to be located in panel room. The OLTC control panel shall comprise of rigid welded structural frames made of structural steel section or of pressed and formed cold rolled steel and frame enclosures, doors and partitions shall be of cold rolled steel of thickness 2 mm. Stiffeners shall be provided wherever necessary. All doors, removable covers and plate shall be gasketed all around with neoprene gaskets. Panel shall be dust, weather and vermin proof providing degree of protection of IP54, colour of finish shade for interior and exterior shall be glassy white and light grey semi glossy shade 631 of IS-5 respectively. Earthing bus shall be of 25 x 6 mm copper. The OLTC remote control equipment shall comprise the following:

i.Control switches; Raise/ Off/ Lower (spring return to normal type) or independent push buttons.

ii. If automatic operation is specified, auto / manual selector switch (maintained contact type) and other items as listed.

iii. If parallel operation is specified, master / independent / follower selector switch (maintained contact type) with ‘out of step’ annunciation.

iv. Tap position indicator.

v. Facia type alarm annunciators with “accept”, “lamp test” facilities and hooter / buzzer for alarms as listed.

vi. Necessary auxiliary relays.

vii. Lamp indications for:

- Tap change in progress
- Lower limit reached
- Upper limit reached
- Transformer cooler control apparatus (if applicable)

i.Cable glands for power and control cables.

ii. 240 V rated panel space heater with thermostat.

iii. CFL type interior lighting fixture with lamp and door switch.

iv. MCBs.

v. Terminal blocks.

vi. Internal wiring.

vii. Earthing terminal.

viii. Hook up for the remote operation of tap lower and raise operation and contact/ signal for tap position indication to Purchaser's DCS shall be incorporated in the panel.

(l) Fittings and Accessories :

The following fittings and accessories shall be provided with transformer:

(a) Inspection manhole in the cover.
(b) Lifting lugs for both the transformer and the core.
(c) Name plate, rating plate and diagram plate.
(d) Oil level indicator with minimum marking.
(e) Bidirectional wheels for movement of the transformers.
(f) 10% excess oil
(g) Four jacking pads for lifting the transformer with jacks.
(h) Separately mounted, water proof and dustproof marshalling box housing the oil temperature indicator and winding temperature indicator with alarm and trip contacts and marshalling facilities for electrical devices mounted on transformer.
(i) Weather proof dehydrating breather with activated alumina or silica gel as the dehydrating agent.

4.9 Operational Requirements

(a) Transformers shall operate without injurious heating at the rated MVA/ KVA at any voltage within ± 10 percent of the rated voltage of that particular tap in accordance with IS:6600.

(b)Transformers shall be capable of delivering the rated current at a voltage equal to 105% of the rated voltage without exceeding the limiting temperature rise.

(c)Transformer for two or more limits of voltage or frequency or both shall deliver its rated MVA/KVA under all the rated conditions of voltage or frequency or both; provided an increase in voltage is not accompanied by a decrease in frequency.

(d)Transformers shall be capable of operation continuously, in accordance with the applicable standard loading guide at their rated MVA/KVA and at any of the specified voltage ratios. Under these conditions, no limitations by terminal bushings, on-load tap changers or other auxiliary equipment shall apply.

(e)The neutral terminal of windings with star connection shall be designed for the highest over current that can flow through this winding.

(f) The transformers shall be designed with particular attention to the suppression of harmonic voltage, especially the third and fifth, so as to eliminate wave form distortion and any possibility of high frequency disturbances reaching a magnitude as to cause interference with communication circuits.

4.10 Tests and Inspection

All transformer shall be routine tested as per latest edition of IS: 2026. Transformer oil shall be tested as per IS: 335. The tests shall be carried out in the presence of the Purchaser/ Purchaser's representative. In addition to the routine tests, Type tests viz. Lightning impulse test [IS 2026 (Part 3)], Temperature-rise test [IS 2026 (Part 2), Pressure test shall be carried out, if these tests have not been already carried out on transformer of similar or higher capacity in the last five years. Type test certificates shall be submitted by the vendor. Any additional tests/ inspections requirement by employer at OEM's/ Manufacturer's workshop shall be finalised during QAP submission by Contractor and Approval by employer/ engineer. The agreed and approved tests/ inspections shall be carried out accordingly during Factory Acceptance Test at OEM's/ Manufacturer's workshop.

4.11 Losses

The losses under the no load and full load condition, at the rated voltage and frequency shall be indicated by the vendor at 75 Deg. C. These shall be guaranteed within tolerable limits specified in IS : 1180 / IS 2026 at center tap position. The purchaser has the right to impose penalty charges or reject the transformer in case of any difference in the test and guaranteed values.

4.12 Rejection

Employer may reject any transformer if during tests or service any of the following conditions arise:

- No load loss exceeds the guaranteed value by 20% or more.
- Load loss exceeds the guaranteed value by 20% or more.
- Impedance value differs the guaranteed value by +10% or more (zero negative tolerance)
- Oil or winding temperature rise exceeds the specified value by 5 deg. C
- Transformer fails on power frequency voltage withstand test.
- Transformer fails on impulse test.
- Transformer is proved to have been manufactured not in accordance with the agreed specification.

Employer reserves the right to retain the rejected transformer and take it into service for rectification.

Employer reserves the right to retain the rejected transformer and take it into service until theContractor replaces the defective transformer by a new transformer.

5. Medium Voltage Variable Frequency Drives (6.6kV)

VFDs should be used where speed variation is essential for maintaining a process variable at a particular set point or matching a given performance profile. VFDs should be used for enabling process optimization, improving energy management etc.

The VFD should produce a variable voltage and variable frequency output to provide continuous operation over the application speed range. The VFD should be capable of operating with the rated current permanently or with disconnected motor at rated voltage.

The VFD should be factory pre-wired, assembled and tested as a complete package, inverter plus Phase Shifting Transformer, by the VFD supplier.

Wherever possible the selected drive should utilize the minimum number or pulses required to perform the desired task whilst complying the national and international guidelines on harmonic emissions.

Each VFD should employ insulated Gate Bipolar Transistors (IGBTs) on both the rectifier and frequency convertor.

VFDs should employ either closed loop, Flux vector control or direct torque control methodologies.

The Drive should accept nominal input voltage of 6.6 kV, 50Hz for fan & pump application.

The supply input voltage tolerance should be +/- 10% of the nominal line voltage.

VFD should support various control voltage supply from 110VAC to 230VAC (+/- 10%) or 415V AC, 3Phase, 4wire only if required.

Auxiliaries (e.g. light, space heaters, etc.) should be supplied with single phase 230V.

VFD should inherently protect motor from high dv/dt stress (maximum accepted level 1000V/µs).

The VFD should consist of integrated transformer dry type with Class H insulation.

VFD should be designed as per the following environmental conditions:

Ambient Temperature	:	0°C to 45°C (32°F to 113°F)
Humidity	:	Relative humidity of 90% (non-condensing) .
Electronic Boards	:	Coated Boards
Transport Temp	:	-5°C to 70°C.
Installation Altitude	:	0 to 1000 m (3,300 ft.) above sea level, without de-rating

The drive shall be of modular design to provide easy and fast maintenance. Metal barriers shall be provided between each vertical section and between the low voltage compartment and the power section. Personnel shall have access to the low voltage compartment, with the VSD energized, without being exposed to any medium voltage.

The drive's characteristics should as a minimum achieve the following:

Input	Pulse diode rectifier bridge
Output	PWM with IGBT inverter cell
Input voltage	6.6 kV
Input frequency	50 Hz +/- 5%
Overload Capabilities	Standard overload 120% 60s/10min and 150% 3s/10 min High Overload 150% 60s/10 min, 185% 3s/10 min
Total harmonic (THDi)	Complying to standard IEEE 519
Power factor	≥ 0.95 from 20% to 100% load
Cable entry	Bottom
Efficiency at rated power	≥ 95%
Minimum Pulses	30
Type of motor	Asynchronous, synchronous motor, permanent magnet motor
Control Voltage	110V AC - 230 V AC or 415V AC, 3Phase, 4wire only if required
Communication	Modbus TCP, Ethernet IP
HMI	HMI to be provided as per manufacturer’s standard
Control interface	8 DI, 2AI, 2AO, 3 relay outputs
Protection	IP31
Paint	RAL 7035
Cooling	Forced Air Ventilation
Reference standard	IEC EN 61800-3, IEC 61800-4, IEC EN 61800-5-1, IEC EN 60529, IEEE 519

Performance guarantee considering the climatic conditions the drive will experience, its minimum operating limits that it can sustain in those conditions (load torques, starts per hour, harmonic emission and speed range) should be obtained from drive’s vendor prior to the procurement.

Also, the vendor should provide Technical Datasheets, Layout/ arrangement drawings, Single line diagrams, Wiring diagrams, Termination drawings, Spare parts list, Programing manual, Operation and Maintenance manual, reports of tests and commissioning with protocols.

The selected VFD should employ internal optimization algorithms to minimize energy usage, especially when not operating at rated speeds and torque.

The selected VFD should have a configurable, proportional, integral and derivative controller.

The selected drive should incorporate motor protection features including:

1. Earth fault detection
2. Motor overload prevention

The VFD shall be provided with motor overload protection in any operating conditions. VFD output waveform shall be suitable for operating a squirrel cage induction motor without de-rating or requiring additional service factor. VFD output current waveform shall be inherently sinusoidal between 10% and 100% speed regardless of the load.

The VFD shall have a “normal duty” rating of 100% continuous current. It shall be able to manage 120% overload for one minute, once every 10 minutes (Class 1 according IEC146-1-1) and 150% overload for three seconds, once every 10 minutes .

VFD Power Inverter Bridge shall be built with the newest power component technology like IGBT communication between controller and power electronic shall be done by means of optic fiber.

Control system shall be programmable by means of a 7” LCD touch-panel display. By means of the touch screen the following operations shall be done:

- Monitoring of actual values and parameters
- Changing of parameter settings
- Diagnostic and Maintenance information
- Exporting files for external usage
- Daily Consumption and Oscilloscope Function

Controlled active rectifiers with harmonic mitigation algorithms should be employed where harmonic emissions will fall out with national guidelines.

All inspection and testing procedures shall be developed and controlled under the guidelines of the Manufacturer’s quality system. This system must be registered to ISO 9001 and regularly reviewed and audited by a third-party registrar.

All subassemblies of the VFD shall be tested completely and detailed in manufactures workshop. All tests required by the codes and standards as well as all tests according manufacturers requirement.

VFD´s type test report shall be shown at random.

The test program for the workshop test should be submitted at least 2 weeks prior the start of the tests.

VFD shall be tested at rated voltage and with rated current.

Recommendations of spare part for commissioning and alternative operation and maintenance shall be submitted by manufacturer

6. Neutral Grounding Resistor

6.1 General

This specification covers the requirements of design, manufacturing testing at works and dispatch in well packed condition of Neutral Grounding Resistors required for connecting to the neutral of power transformer to obtain a resistance grounded system for limiting line to ground fault current.

6.2 Codes and Standards

The design, manufacture and testing of the NGR covered by this specification shall comply with the latest issue of IS : 3043, unless otherwise specified. Neutral grounding resistor shall conform to latest applicable standards.

The list of some of the applicable Indian Standards is as given below: IS 3043 Code of Practice for Earthing

IEEE 32 Requirements, Terminology and Test Procedures For Neutral Grounding Devices

6.3 Resistor Element

The resistance at the bank shall be of heavy duty non-inductive type having high specific resistance and low temperature co-efficient.

The resistor elements shall be made of jointless, non-corroding, sturdy and oxidation resistant, stainless steel of punched / formed construction.

All internal hardware shall be of stainless steel.

The element material shall possess a balanced combination of properties, uniformity of resistance and mechanical stability over the intended temperature range, without any injurious effects on the elements and its associated insulation.

Resistor shall be comprising of series & parallel combination of resistors.

The resistor assembly shall be designed for a maximum temperature rise as per IEEE 32.

Heavy duty epoxy cast insulators rated for the highest system voltage shall be used to insulate the resistor elements from the body of the housing.

Insulation level for resistor bank shall be as follows :

Highest system voltage	Power frequency withstand voltage	Impulse withstand voltage

Upto 7.2kV	20 kV RMS	60kV peak
Upto 12kV	28 kV RMS	75kV peak

6.4 Housing

The housing shall be metal clad fabricated from 3 mm thick sheet steel, floor mounting type and rectangular in shape. Ventilating louvers if provided shall be covered by fine wire mesh from inside and shall be such that the above top cover of the housing shall be of sloping construction to prevent accumulation of water

The minimum degree of protection for the resistor element shall be IP 34. For outdoor mounted NGRs, the enclosure degree of protection shall be IP 55.

The construction of the resistor assembly shall be such that the minimum required insulation resistance is maintained under all atmospheric conditions, without a space heater. The NGR will be installed in dust prone, hot, humid and tropical atmosphere. All equipment, accessories and wiring shall be provided with tropical finish to prevent fungus growth. The front and back covers shall be removable for access to internal resistor connection and for removal of resistor banks.

The neutral earthing resistor or neutral grounding resistor shall be designed to operate satisfactorily with one face flush to brick/concrete wall.

The enclosure shall be suitable for installation on a concrete foundation.

Each cubicle shall be complete with a front access door with handles, lock and also a removable bolted cover. All doors and removable covers shall be properly gasketed with neoprene rubber gaskets.

All cubicle door hinges shall be concealed type. Each cubicle shall be complete with a suitably mounted cable end box fitted with removable gland plate for fixing cable gland. For termination of XLPE cable, necessary termination kit shall be provided by the Contractor. Each cubicle shall be provided with suitable base channels for direct bolting to the foundation at site. All necessary galvanized bolts, nuts, washers, etc shall be provided by the Contractor.

All external hardware below 10 mm size be of stainless steel and those of higher size of mild steel zinc passivated or cadmium plated.

6.5 Current Transformer

Current Transformer shall when specified in specification be installed in the terminal box for the primary side connection.

All secondary terminals of current transformers shall be wired to a terminal block in an auxiliary cable connecting box. The terminals shall be provided with short circuiting links.

One side of the secondary winding of each current transformer circuit shall be earthed at this terminal block.

Individual terminals shall be provided for each external cable block.

Terminals shall be of the non-loosening wedge type, obviating the need for cable lugs and constructed in such a way that direct contact between screw, bolt or nut and conductor is avoided.

Auxiliary terminal box protection shall be minimum IP 55 for outdoor installation.

6.6 Terminations

The connection box and terminals shall be suitable for the incoming and outgoing cable. Bolted type isolation links shall be provided for connection of cable to the resistor at HV side. Adequate space shall be provided for termination of cable required.

All conductor terminations shall be bolted welded or brazed. Low melting alloys used to join connectors, which would be adversely affected by the resistor operating temperatures, shall not be used. All conductor terminations must be mechanically secured to provide continuous electrical continuity and shall be rated for the full system voltage.

Terminal box protection shall be minimum IP 55 for outdoor installation.

Cable gland plate shall be made of non-magnetic metal.

6.7 Corrosion Protection

All metal parts shall be protected against corrosion and shall be suitable for the environmental conditions specified in.

6.8 Wiring

All internal wiring between equipment and terminal block shall be carried out by PVC insulated 1100 V grade 2.5 Sq. mm. Stranded copper conductor wires.

Each wire shall be ferruled by plastic tube with indelible ink print at both end having terminal block no. - terminal number as per approved schematic wiring diagrams.

All devices and terminal blocks within the terminal box shall be clearly identified by symbol corresponding to those used on applicable schematic/ wiring diagram. 20% spare terminals shall be provided in terminal block.

6.9 Operating Requirements

The NGR shall be suitable for carrying rated current for a duration of 30 seconds under specified condition of ambient temperature, voltage and frequency without temperature exceeding 300 °C.

The resistor shall also be suitable to carry 25% of rated short time current continuously without any harmful effect on any part of NGR.

The housing shall be designed such that the temperature of other metal parts through which current is not required to pass, shall not exceed 35 Deg. C. when rated current is passed through NGR for specified duration.

6.10 Painting

All metal surfaces shall be chemically cleaned, degreased and pickled in acid to produce a smooth clean surface, free of scale, grease and rust.

After cleaning, phosphating and passivation treatment, the surface shall be given two coats of zinc rich epoxy primer and baking in the oven.

After primer, it shall be given two coats of stoving type epoxy paint with shades 631 as per IS : 5.

Painting shall withstand tropical heat and extremes of weather. The paint shall not scale off, crinkle or be removed by abrasion due to normal handling.

6.11 Tests and Inspection

All the test shall be carried out as per applicable standards mentioned above.

All the tests shall be carried out in the presence of Client/ Consultant. In addition, the NGR shall be subjected to stage inspection during process of manufacture at works and inspection at site for final acceptance.

The purchaser's inspection shall, however not absolve the vendor from his responsibility for making good any defects which may be noticed subsequently.

7. D.C. POWER SYSTEM

7.1 General

The power supplies will operate from 415V, 3 phase, 4 wire or 240V, 1 phase AC supply depending upon kVA rating of the equipment and produce designated DC output voltage at full load current. Voltage regulation- 0.02% for 10% mains voltage variation Load Regulation- 0.3% from zero to full load conditions. The power supply shall incorporate an over voltage protection circuit, the components of which shall be independent of the voltage regulating circuit.

7.2 Applicable Standards

The Battery, Battery charger and D.C. distribution board shall conform to the latest applicable standards specified below. In case of conflict between the standards and this Specification, this Specification shall govern.

Title	Code No
Basic climatic and mechanical durability tests for components for electronic and electrical equipment	IS:9000

Environmental tests for electronic and electrical equipment	IS:9000
Metal clad base material for printed circuits for use in electronic and telecommunication equipment	IS:5921
Transformers and inductors (power, audio, pulse and switching) for electronic equipment	IS:6297
Printed wiring boards	IS:7405
Environmental requirements for semiconductor devices and integrated circuits	IS:6553
Terminals for electronic equipment	IS:4007
Factory built assemblies of switchgear and control gear for voltages upto and including 1000 V AC and 1200 V DC	IS:8623/BS:5486/IEC:439
Air break switches	IS : 60947
Miniature circuit breakers	IS /IEC : 60898
HRC cartridge fuses	IS:9224/BS:88
Contactors	IS:13947(Part–3) /BS:775/ IEC:158-1
Control switches/push buttons	IS:60947-5-1
Indicating instruments	IS:1248/BC:89/ EC:51
Degree of Protection	IS:60529
Climate-proofing of electrical equipment	BSCP:1014
Semi-conductor converters	IEC:146
Semi-conductor rectifier equipment safety code	IS:6619
IEEE Recommended Practice for Sizing Nickel-Cadmium Batteries for Stationary Applications	IEEE 1115
IEEE Recommended Practice for Installation, Maintenance, Testing, and Replacement of Vented Nickel-Cadmium Batteries for Stationary Applications	IEEE 1116
Specification for Vented type Nickel Cadmium Battery	IS 10918/IEC 60623
Low-voltage switchgear and control gear	BIS IS/IEC 60947-1 : 2007(R2017) IS 61439

7.3 Arrangements

The DC Supply System shall comprise of the following items:

- Constant voltage, current-limiting rectifier, Float-cum-Boost type battery charger each for 22kV panel and 6.6kV Panel
- One (1) set of battery bank of Ni-Cd maintenance-free batteries each for 22kV panel and 6.6kV Panel
- auxiliary equipment
- distribution section as integral part of the charger cubicle.

The output of the rectifier shall either rapid (boost) charge the battery along with the load or float charge the battery and simultaneously supply the power requirements of the load. In the event of failure of the AC mains supply to the rectifier, the battery shall, without interruption, immediately take over and supply the power requirements of the load.

7.4 Ratings

All components shall be rated to withstand maximum occurring voltages, currents and loads.

7.5 Battery

- Batteries shall be of high performance 110V DC Nickel-Cadmium Maintenance Free type conforming to relevant IS. Battery AH Rating Batteries shall be suitably sized to supply the control requirements of HT breakers and Annunciations, emergency lighting etc. as required.

The AH capacity of the battery shall be worked out as follows:

- AH capacity required, calculated according to IEEE, to meet all continuous load, short duration (8-10 hours) load and momentary load .Considering 10 % towards design margin and 20% towards ageing & maintenance as well as effects of temperature variations, AH capacity selection shall be as worked out or next higher standard rating.

7.5.1 Battery Construction

Batteries shall have cells housed in translucent, high impact plastic containers. Cell terminals shall be of bolted type. The terminal polarity shall be permanently marked.

Battery cells shall be arranged so that each is accessible for test and inspection. Cells shall be arranged in single/double row, single/double tier rack formation and shall be not less than 300 mm above floor level.

Batteries shall be supplied complete with all necessary connections. The connections between tiers and cells and disconnection links shall be of the multi- stranded plastic insulated type.

The battery rack shall be made of mild steel painted with alkali resistant paint and shall be supplied in knocked down condition which could be bolted and assembled at site.

The top tier of cells shall not be more than 1.75 meter above floor.

The battery shall be installed in AC room with exhaust facility or as recommended by the battery supplier for warrantee of battery capacity and life.

7.6 Battery Charger

Float-cum-Boost charger shall be provided for each battery set. The Float and Boost sections shall be independent of each other. Power supplies to Float section and Boost section shall also be separate to improve reliability of the chargers

7.7 Charger Ratings

Float charger shall be designed to cater:

- to all the loads, including momentary peak loads, of the DC system
- Float charge the connected battery
- Add 15% as design margin, in terms of ampere rating

Ampere rating based on the above calculations or next standard higher rating shall be selected.

Boost shall be designed to cater:

- Boost charged a fully discharged battery at boost charging current recommended by the battery supplier to all the loads, including momentary peak loads, of the DC system
- Add 15% as design margin, in terms of ampere rating Ampere rating based on the above calculations or next standard higher rating shall be selected.

7.8 DC Output Voltage Control

The connected load of the DC system, namely, control circuit equipment, protective relays etc. Are normally designed for a voltage variation of (+) 10% and (-) 10% of the rated voltage. In view of this, in case the output voltage of the charger, either during Float mode or during Boost mode exceeds (+) 10% limit, suitably Voltage Dropping Diodes or suitable voltage dropping arrangement shall be provided to prevent the connected equipment from continuous over voltages.

7.9 DC System Earthing

The DC system shall be free from earth. Therefore, an earth fault detection system must be applied.

7.10 Battery Charger panel construction

Enclosure shall be fabricated in accordance with this volume. The protection class of the unit shall be at least IP42. Maximum height shall not exceed 2.25 m. The Float charger section and the Boost charger section shall be physically separate so that it shall be possible to work on one section while the other section is operational.

The following features for personal and electrical safety shall be incorporated:

- Compartments which have to be accessible during operation, e.g. for fuse replacement shall contain no exposed live parts under normal operational conditions in opened situation.
- Maintenance of either charger shall be possible independently with the other charger supplying the loads.
- Adequate protection in the form of vertical and horizontal screening between the sections shall be provided to minimize the risk of accidental short circuits and to limit their propagation, if occurring.

Materials

Fuses

The fuses shall be of fast acting HRC type suitable for the thyristor duty in accordance with the relevant IS.

Contactors

The utilisation category for DC contactors shall not be less than DC-3 and for AC contactors not less than AC-3.

Printed Circuit Boards

All printed circuit cards shall be plug-in type, interlocked to prevent insertion in a wrong slot. Each card shall have LED indication on its front plate to indicate normal condition and readily marked test pins. All PCBs shall have test points which shall be easily identifiable and accessible for testing.

7.11 Auxiliary Equipment

Indications

The following indications (LED lamps) shall be provided on the cabinet door:

- AC Supply On
- DC Output On
- Float Charger On
- Boost Charger On

Alarms

The following alarms (facia annunciator with audio-visual alarm) shall be provided on the cabinet door:

- AC Mains Supply Failure
- Charge failure
- DC System over voltage

8. High Voltage Induction Motors

This shall be in accordance with the HT motors as mentioned in Mechanical Specifications.

9. Electric Motors (LT)

9.1 General

Electric motors shall comply with IS 12615, IEC 60034, IEC 60072 and IEC 60085 and shall be bi-directional and rated on the basis of duty type S1 (maximum continuous rating). Motors shall be of minimum 'Energy Efficient' type IE3 .Where the power supply permits motors shall be preferentially of the 3 phase type. Motors shall be designed to operate on the supply voltage specified for the works. Motors shall be capable of operating under conditions of three phase supply imbalance where the negative and zero phase sequence components of the voltage do not individually exceed 2% of the positive phase sequence components.

9.2 Codes and Standards

The design, manufacturing and testing of the motors covered by this specification shall comply with the latest issue of the following standards:

IS 12615	Energy Efficient- Three Phase Induction Motor
IS 9283	Submersible Motors
IS 2148	Flameproof Motors
IS 6341	Increased safety of motors
IS 12065	Permissible limits of Noise Level
IS/IEC 60034-Part I	Performance of Motors
IS/IEC 60034-Part V	Degree of Protection
IS 1231, IS 2223, IS 2254	Dimensions of motors
IS: 4029	Guide for testing three phase induction motors.
IS 12075	Mechanical Vibration of Rotating Electrical Machines
IS: 6362	Designation of methods of cooling for rotating electrical machines.
IS 2253	Designation for types of construction and mounting arrangement of rotating electrical machines.
IS: 900	Code of practice for installation and maintenance of Induction motors.
IS: 4889	Determination of efficiency of Rotating electrical machines.

9.3 Construction

Motor construction shall provide a degree of protection as follows:

IP 54 - internal use including applications in dusty environments.

IP 55 - external use in exposed locations with a canopy.

Motor mounting arrangement shall be to suit application.

Motor cooling shall be totally enclosed fan cooled. Other forms of ventilation may be used with the approval of the Engineer.

Motor bearings shall be provided with facilities to add additional lubricant. For grease lubricated bearings grease nipples shall be provided and a grease relief feature incorporated. Oil lubricated bearings shall be provided with site glasses which provide an accurate indication of bearing oil level when the motor is in use.

Motors shall be designed for normal sound power as defined by IS 12615 or IEC 60034.

Windings shall be insulated to class F. However, temperature rise at full load shall be limited to that for Class B insulation.

Where specified motor windings shall incorporate:

thermistors (PTC type), or

resistance thermometers (PT 100).

In each instance the temperature detecting devices shall be in close thermal contact with each phase of the stator windings. All thermistors shall be connected together to provide a single electrical circuit for connection to an external relay which will be capable of tripping the motor.

Anticondensation heaters shall be sized to raise the temperature inside the motor several degrees above the dew point temperature. The heater surface temperature should not exceed 200°C Heaters shall be automatically disconnected when the motor is switched on.

Terminal boxes shall of weather proof construction designed for outdoor services. All the terminal boxes shall have IP 55 degree of protection. To eliminate entry to dust and water, gaskets of neoprene or approved equivalent shall be provided at cover joints and between box and motor frame. It shall be suitable for bottom entry of cables. It shall be capable of being turned through 360 degrees in steps of 90 degrees. The terminals shall be of the stud type with necessary plain washers, spring washers and check-nuts. They shall be designed for the current carrying capacity and shall ensure ample phase to phase to ground clearances. Suitable cable lugs shall be supplied.

Accessories

Two independent earthing points shall be provided on opposite sides of the motor, for bolted connections. These earthing points shall be in addition to earthing stud provided in the terminal box.

9.4 Performance and Characteristics of LT Motor

1. Motors shall be capable of giving rated output without reduction in the expected life span when operated continuously under either of the following supply condition

Supply Condition

(a) Variation in supply voltage

from rated voltage ±10%

(b) Variation in supply frequency

from rated frequency ±5%

(c) Combined voltage and

Frequency variation ±10%

2. Motors shall be suitable for the method of DOL, Star Delta, Softs tarter and VFD starting
3. The minimum permissible voltage shall be 85% of the rated voltage during motor starting.
4. Motors shall be capable of starting and accelerating the load with the applicable method of starting, without winding temperatures reaching injurious levels, when the supply voltage is in the range of 85% of the rated motor voltage to maximum permissible voltage .
5. The locked rotor current of the motor shall not exceed 600% of full load current (subject to tolerances as per the applicable standard) unless otherwise specified. The locked rotor current of VFD controlled motor shall be within the limit of IS 12615 / IEC 60034.
6. Motors shall be capable of developing the rated full load torque even if the supply voltage drops to 70% of the rated voltage. The pull out torque of the motor shall be at least 205% of full load torque.
7. Motors when started with the driven equipment coupled shall be capable of withstanding at least three successive starts from cold conditions & two start from hot condition without injurious heating of windings. The motors shall also be suitable for four equally spread starts per hour under the above referred supply condition.

9.5 Rated Output

The power output rating of the motor shall be larger of the following:

115% of the power input to the driven equipment – pump, blower etc. at duty point .

105% of the maximum power input to the driven equipment under any operating condition.

9.6 Insulation

The insulation shall be given tropical and fungicidal treatment for successful operation of the motor in hot, humid and tropical climate. The motors shall be provided with class F insulation with temperature rise limited to that of class B insulation.

9.7 LT motors should have following provision

a) For Motor < 75 KW thermistor should be provided and feedback of thermistor should be taken to MCC.

b) For Motor >=75 KW space heater should be provided which shall be thermostatically controlled.

9.8 Earthing

Earthing of the motor shall be done in accordance with the relevant provisions of IS:3043.

9.9 Induction Motor (Submersible Pump)

The submersible motor shall conform to IS:9283 and the submersible cable shall conform to IS:9968. Submersible motors shall have IP 68 degree of protection. The motor shall be suitable for continuous duty as well as intermittent duty with or without full submergence of the motor. Each motor shall be provided with minimum 25 m length of power & control cables and 15 m length of lifting chain. Junction box(es) for terminating power & control cables for each motor. The size of the conductor and length of cable should be suitably selected so that the voltage drop at motor terminals does not exceed 3 percent of the rated voltage. Earthing of the motor shall be done in accordance with the relevant provisions of IS: 3043:1987.

10. Cables: MV, LV, Control cable

10.1 Applicable Standards

The cables shall conform to the latest applicable standards specified below.

IS : 1554 Part (I)	PVC insulated (heavy duty) electric cables for working voltage upto and including 1100 Volts.
IS : 7098 Part (I)	Cross linked polyethylene insulated PVC sheathed cables for working voltages upto and including 1100 Volts.
IS : 7098 Part (II)	Cross linked polyethylene insulated PVC sheathed cables for working voltages from 3.3 kV upto and including 33 kV.
IS:5831	PVC insulation and sheath of electric cables
IS:8130	Conductors for insulated electric Cables
IS:10810	Methods of test for cables

IS:10418	Specification for drums of electric cables

10.2 Features of Construction

(a) XLPE Insulated HV Power Cables (22kV and 6.6kV) :

The conductors shall be screened by extruded semi-conducting compound and XLPE insulated. The cores shall be screened by extruded semi-conducting compound in combination with non-magnetic metallic tape (copper tape preferred).The inner sheath over laid up cores and outer sheath over the armour shall be extruded black PVC compound type ST-2. Core identification shall be by printed numerals. The construction, performance and testing of the cable shall comply with IS 7098-Part 2 (Cross Linked Polyethylene Insulated PVC Sheathed Cables for working voltages from 3.3kV upto and including 33kV).Core Identification shall be by printed numerals.

All the cables shall be FRLS type.

All HV power cables 22kV and 6.6kV shall be of Unearth grade.

(b) LT Cables

(i) 1100 V grade PVC insulated Power / control cables

The cables shall be insulated with extruded PVC compound type C, provided with inner sheath and outer sheath of extruded black PVC compound type ST-2.

The construction, performance and testing of the cable shall comply with IS 1554 - Part 1 (PVC insulated heavy duty electric cables for working voltages upto and including 1100 V).

All the control cables shall be stranded copper conductor type conforming to IS 1554-part I.

All the cables shall be FRLS type.

(ii) 1100 V Grade XLPE Insulated Power Cables

The cable shall be extruded XLPE insulated. The inner sheath over laid up cores and outer sheath over the armour shall be extruded PVC compound type ST-2. Core identification shall be by printed numerals. The construction, performance and testing of the cable shall comply with IS 7098-Part1 (Cross linked polyethylene insulated PVC sheathed cables for working voltages upto and including 1100 V).

All the cables shall be FRLS type.

10.3 Cable Rating

The Contractor shall ensure that cable and wires associated with the distribution and control systems, plant wiring and all other installations throughout the Works are adequately rated for their use.

In assessing the rating of any cable or wire, the following factors shall be taken into account:

- Supply voltage and frequency
- Maximum voltage drop permissible
- Type and magnitude of load
- Fault level and duration related to circuit protection relays and fuses
- Circuit overcurrent protection
- Route length and disposition of cables
- Ambient temperature
- Method of installation

All power cables shall be sized for continuous current carrying capacity at the ambient temperature of 45 0C. The design current of any circuit shall exceed the full load current of the supplied device by at least 10%. Power cables shall be sized to limit the maximum voltage drop to no more than 3 %.

Load current: De-rating factor (Overall) under the conditions of laying as 0.7

Voltage drop: The feeder voltage drop shall be restricted to 2% and the motor cable voltage drop shall be restricted to 3%.

Short Circuit withstand time as 1.0 sec.

10.4 Cable Colours

All cable cores shall be colour coded throughout their length and shall be so connected between switchboard, distribution board, plant and accessories, that the correct sequence or phase colours are preserved throughout the system.

The colour coding should be as follows:

3 phase	red, yellow and blue
single phase or dc	red and black
earth	green/yellow
control	blue (dc), red (ac)

10.5 Cable Glands

All power and control cables shall be terminated by supplying of double compression type cable glands. Cable glands shall be of robust construction, capable of clamping the cable and armour rigidly without injury to insulation and provide dust/leak proof termination.

These cable glands shall be heavy duty brass casting, machine finished and tinned or nickel plated to avoid corrosion and oxidation. Rubber components used in cable glands shall be of neoprene and of tested quality. Cable sizes shall be marked on the cable glands for easy identification.

Each gland shall comprise of the following:

Gland body, clamping armour and neoprene compression ring, Check nut and 2.3 to 3 mm thick neoprene washer etc.

Where single core glands are required these shall be of the non-magnetic type.

10.6 Cable Lugs

Cable lugs shall be of tinned copper, solderless crimping type of reputed make conforming to relevant standards suitable for aluminium or copper conductor cable connections.

10.7 Cable Carrier System

10.7.1 General

The cable carrier system covers the supply of cable racks, cable trays and its supporting cabling accessories, conduits and pipes. It shall be the responsibility of the Contractor to complete the cabling system in all respects. Power cables shall be laid on Ladder type cable tray and control cables shall be laid on Perforated Cable tray. In case of road crossings cables shall be laid in RCC hume pipes.

10.7.2 Applicable Standards

Steel for general structural purposes	IS:2062
Dimensions for hot rolled steel beam, column channel and angle sections	IS:808
Code of practice for use of metal arc welding for general construction in mild steel	IS:816
Hot deep galvanizing of iron & steel	IS:2629
Methods of testing uniformity of coating of zinc coated articles	IS:2633
Hot dip zinc coatings on structural steel and other allied products	IS:4759

10.7.3 Cable Trays and Accessories

Cable trays shall be of Galvanised Steel complete with all necessary coupler plates, elbows, tees, bends, reducers, stiffeners and other accessories and hardware as required. All the cable trays shall be hot dip galvanised. All hardware (i.e. bolts, nuts, screws, washers, etc.) shall be hot dip galvanised.

Each 2.5 metre section of all types of cable trays and all elbows, tees, crosses, etc. shall be provided with two side coupler plates and associated bolts, nuts and washers.

Perforation process, hole punching, modifications and changes shall be done before galvanisation/coating.

Cable tray for use in corrosive areas shall be suitably protected. Cable tray supports shall be of a compatible finish with the associated cable tray.

Each continuous laid out length of cable tray shall be earthed at minimum two places by GI flats to the main earthing grid, the distance between earthing points shall not exceed 10 meters.

The sizing of the cable tray shall provide a minimum of 25% spare capacity. The tray shall be run at least 150 mm clear of plumbing and mechanical services.

Outdoor cables, for interplant cabling, shall be laid in built up RCC trenches. Cable trays of adequate width and multi-tier formation as required for cabling shall be installed in cable trenches. Adequate walkway space of minimum 500mm width shall be provided inside the cable trenches for the purpose of cable installation and future maintenance / inspection. Adequate slope shall be provided to the cable trench bottom to drain away rain water accumulated inside the trench. Trench top, however, shall be levelled throughout. Pre-cast RCC covers with lifting facility shall be provided to cover the built-up trenches.

10.7.4 Conduits and pipes with accessories

The contractor shall supply galvanised steel/coated conduits, galvanised mild steel pipes and flexible conduits required for the cabling work.

The conduits/pipes/flexible conduits and all the other accessories shall conform to the following:

(a) Conduits shall be seamed by welding and shall be hot dip galvanised both inside and outside. Conduits and fittings shall be as per relevant standards.

(b) Pipes shall be of heavy-duty type as per relevant standards and shall be hot dip galvanised both inside and outside.

(c) Flexible conduits shall be made with bright, cold rolled, annealed and galvanised mild steel strips. Flexible conduits and adaptors shall be as per relevant standards.

10.8 Marking Locations of Underground Cables

The location of all underground cables shall be engraved on brass or other non-corrodible plates to be fixed to the exterior surface of all walls of buildings 300 mm above ground

level and directly above the point where cables pass through the wall. In addition concrete marker posts shall be installed at intervals of not more than 50 m and at all junctions and changes of direction along the cable route.

10.9 Galvanizing

Wherever galvanizing has been specified, the hot dip process shall be used. The galvanised coating shall be of uniform thickness. Galvanization shall be as per IS 2629. Galvanizing shall be carried out after all drilling, punching, cutting, bending and welding operations have been carried out. Burrs shall be removed before galvanizing. Any site modification of galvanized parts should be covered well by zinc rich primer and aluminium paint.

11. Earthing and Lightning Protection System

11.1 General

The earthing and lightning protection system covers earthing conductors, earth electrodes and accessories. Metallic frame of all electrical equipment shall be earthed by two separate and distinct connections to earthing system , Crane rails , tracks , metal pipes and conduits also shall be earthed at two points . Steel RCC Columns , metallic stairs and rails of the building housing electrical equipment also shall be connected to nearby earthing grid conductor . Metallic sheaths/ screens and armour of multicore cables shall be earthed at both ends. Metallic sheaths and armour of single core cables shall be earthed at the switchgear end only. Every alternate post of switchyard fence shall be connected to the earth grid by GI flat and gates by flexible lead to earthed post. Each Continuous laid length of cable tray shall be earthed at minimum two places by GI Flats to earthing system , the distance between the earthing points shall not exceed 10m. Lightning Protection System shall comprise of vertical / horizontal air terminations , down conductors , test limits, joints and bonds, earth termination and earth electrodes. Air terminations , down conductors and test links shall be of galvanised iron conductors and shall be protected against corrosion and earth connection below the ground level shall be of Galvanised iron.

Lightning Protection System down conductors shall not be connected to other earthing conductors above the ground level.

11.2 Applicable Standards

The earthing and lightning protection system shall conform to the Indian Electricity rules, and the latest applicable standards indicated below:

Code of Practice for Earthing : IS:3043

Code of Practice for the Protection of building and allied structure against lightning	:	IEC:62305B
Hot dip galvanizing	:	IS:2629, 2633, 4759
Structural steel	:	IS:2062 & 808
Welding	:	IS:816

11.3 Earthing Conductor

The electrical installation shall where required be connected to the general mass of the earth by an earthing conductor. The material used for the earthing conductor shall be as follows:

(a) conductors above ground shall be galvanized iron flat ;

(b) conductor buried in the ground or embedded in concrete shall be galvanised iron, rod / flat. Allowance shall be made for reduction in the cross section of the iron over the design life of the earthing system.

The earth electrode system shall comprise one or more earth electrodes, earthing network, mesh or a combination of these in order to obtain the required earth electrode resistance as per IS 3043.

Earth electrodes where used shall be of heavy duty galvanised iron of not less than 40 mm NB and 3000 mm long. Where multiple electrodes are used they shall be separated by a distance of not less than the driven length.

Each earth electrode pipe shall be welded at the top to a mild steel plate to which the earthing tapes shall be connected. These connections shall each be housed in individual concrete inspection chamber set flush to the finished ground level and shall allow disconnection for testing of individual electrodes. The chamber shall be permanently marked `Electrical Earth'.

All materials used for the earth electrode installation shall be purpose made for the application and site conditions and shall be approved by the Engineer’s Representative.

Unless otherwise stated all excavation for the installation of the earth electrodes and the inspection pit shall be carried out by the Contractor.

After the earth installation has been completed the Contractor shall demonstrate to the Engineer’s Representative that the resistance of the electrodes to earth and the continuity of the earth network are within the limits specified. Any additional earth electrodes and test instruments required for the tests shall be provided by the Contractor.

The lightning protection shall be provided by the contractor as per code of practice for lightning protection – IEC:62305

11.4 Main Equipotential Bonding Conductor

Main equipotential bonding conductors shall be provided to connect the earth electrode system to conductive parts forming the Works.

11.5 Galvanizing

Galvanizing shall be in accordance with the specification specified in this volume.

12. Lighting System

12.1 General

The entire lighting system including indoor, peripheral and outdoor/street lighting shall be LED only.

12.2 Applicable Standards

The design, manufacture and performance of equipment shall conform to the latest standards specified below.

Codes	Description
IS 1293	3 pin plugs & sockets
IS 3854	Switches for domestic & similar purpose
IS 732	Code of practice for electrical wiring installation
IS:1913	Electrical lighting fittings general and Safety requirements
IS:6665	Code of practice for industrial lighting
IS: 3646	Code of practice for interior illumination
IS:3646(Part-III)	Calculation of co-efficient of utilization
IS 16101	General lighting LED and LED Modules
IS 15885 (Part-2/sec-13)	Safety of lamp control gear
IS 16104	DC or AC supplied electronic control gear for LED modules
IS:5077	Decorative lighting outfits
IS:10322/BS:4533	Flood lights
IS:10322 Part 5	Luminaries for street lighting
IS:3553	Water tight electric lighting fittings
IS:7569	Cast acrylic sheets for use in Luminaries
IS :1944	Lighting of Public Thoroughfare
IS:10322	Specification for Luminaries (Part I to V)

IS 16107 (Part 1 &2)	Luminaries performance :

12.3 Types of Lighting System

12.3.1 Normal A.C. lighting

All indoor, peripheral and outdoor areas will be provided with normal 240V, 1phase supply AC lighting and the same will be available as long as normal AC supply is healthy.

12.3.2 Emergency Lighting

Emergency lighting shall make use of identical lighting fixtures as that of “Normal” lighting and will form a part of overall lighting scheme. They shall remain On along with “Normal” lighting fixtures and will continue to remain On in case of failure of “Normal” lighting supply. The emergency lighting fixtures will be backed up by suitably rated Inverter(s) with battery backup, providing back up of minimum 2 hours.

Requirement of “Emergency” lighting fixtures, in terms of “Normal” lighting fixtures shall be as follows:

- 100% at stair cases and escape routes/corridors lighting
- 100% of Exit sign lighting
- 50% of Control Room lighting
- 30% of Electrical Rooms lighting & Cable Cellar
- 30% of indoor process plant such as pumps room, blowers room etc.
- 35% of Admin building, Office area lighting

12.3.3 Outdoor Lighting

Street lighting shall be fed from solar panels-based power supply as well as main grid based power supply. Normally power comes from solar panel, when solar power is not available grid power will able to cater solar street lighting. Necessary storage batteries, inverters, timers for automatic control etc. shall be included as a part of solar power and street lighting control system.

12.4 LUX Table

All internal and external areas shall be provided with lighting. The illumination levels to be achieved shall be as follows:

Area	**Illumination Level (Lux)**
Pump house	200 Lux
Battery room	150 Lux

Machinery service area	200 Lux
Offices and conference rooms	300 Lux
Switchgear rooms	250 Lux
Control rooms	500 Lux
Auxiliary equipment area	200 Lux
Cable basement	100 Lux
All other indoor areas	100 Lux
Outdoor platforms and walk ways	100 Lux
Building entrance	100 Lux
Outdoor plant areas	20 Lux
Switchyard & Transformer Area -General -On Equipment	 20 Lux 50 Lux
Outdoor Switchyard	30 Lux
Lockers ,Toilets and wash rooms	150 Lux
Roads	20 Lux
Lift Car	200 Lux

12.5 Lighting Design & Distribution

The entire lighting system shall be adequately rated, bringing down the fault level of the lighting system to around 3.0 kA. In no case, lighting circuits (including MCBs) shall be directly connected to 50 kA rated power system.

Main lighting distribution boards shall be powered through main LV switchgear Panel. Further the power from Main lighting distribution boards will be provided to various areas by Lighting panels or LDBs in respective areas and circuit wiring to the lighting fixtures shall be made from these lighting panels.

Lighting fixtures and fans will be grouped on the circuit wherever required. However, separate circuits shall be used for receptacles wiring.

All the wiring of light fittings shall be by armoured copper cable.

Generally maintenance factor of 0.7 shall be considered for lighting fixtures in general plant area and 0.8 in offices and other air conditioned areas.

12.6 Lighting Fixtures

All light fixtures shall be complete with all the accessories including the control gear (normally integrated mounted), dust vermin and weather proof having minimum IP 42 degree of protection for indoor lighting and minimum IP 65 degree of protection for outdoor use.

Each fixtures shall be provided with terminal block and cable gland suitable for termination of 1 no. copper conductor PVC - A - PVC cable of 4 sqmm size.

All components in the fixtures shall be rated for 230 V and shall be suitable for a voltage variation of +/- 10%, 50 Hz +/- 5% single phase neutral supply. DC light fixtures shall be suitable for 110V DC. All components shall be suitable to withstand 10% voltage variation.

Each lighting fixtures shall be provided with one no. earthing terminal inside the terminal box.

12.7 Luminaires

The Luminaires shall be designed so as to facilitate easy maintenance, including cleaning, replacement of lamps/starters etc.

All Luminaires shall be supplied complete with lamps suitable for operation on a supply voltage of 240V, 50Hz and the variation in supply voltage (±10%) and frequency(±5%).

All the lighting fixtures shall be LED based. The entire lighting system (indoor & outdoor) shall be LEDs based.

All the luminaries shall be of standard construction with ISI mark and in accordance with relevant IS.

Luminaires shall be designed for continuous trouble-free operation without reduction in lamp life or without deterioration of materials and internal wiring. Outdoor fittings shall be weather-proof and rain-proof type.

Type of Luminaires to be used:

LED High Bay Luminaire – In pumphouse

LED Industrial Lighting Luminaire – In Cable Gallery, Battery room , Transformer Area

LED Tube light Batten –In Washroom, Staircase Area

LED Street Light with stand alone Solar system- On roads

LED flood light – On the side walls of pumphouse indoor area and for outdoor peripheral lighting

2X2 Troffer LED Light – In Panel Room

12.7.1 LED Luminaire

All LED luminaire shall be provided with toughened glass and shall have thickness of sufficient strength and high efficiency prismatic diffuser under the LED chamber to protect the LED and luminaire.

Suitable reflector / lenses may also be provided to increase the illumination uniformity and distribution for LED.

The fixture shall be designed so as to have lumen maintenance of at least 70% at the end of minimum 50000 hours (L70) at design temperature of 35 degree C.

Adequate heat sink with proper thermal management shall be provided such that LED soldering point temperature shall not go beyond 75 degree centigrade.

Power factor of complete fitting shall be more than 0.95 at full load 240V and THD<10%

The LED luminaire shall be free of glare. Colour rendering index (CRI) shall be > 80 for indoor lighting and CRI >70 for outdoor lighting.. System luminous efficacy shall be ≥100Lm/Watt for all fixture.

The luminaire shall be provided with inbuilt surge protection of not less than 4 kV to prevent damage to the driver in case of sudden voltage surge.

The luminaire shall be provided with open/short circuit protection

Each luminaire shall be complete with accessories like Driver, power factor improvement capacitors, etc. These shall be mounted as far as possible in the luminaire housing only. If these cannot be accommodated integral with the luminaire then a separate metal enclosed control gear box shall be included to accommodate the control accessories together with a terminal block suitable for connections. Outdoor type fixtures shall be provided with outdoor type weather-proof box with IP 55 or better.

Each luminaire shall have a terminal block suitable for loop-in, loop-out and T-off connection by 250/400 V, 1 core, PVC insulated copper/aluminum conductor wires up to 4 sq.mm in size. In outdoor areas the termination at the luminaire shall be suitable for 1100 V, PVC insulated, copper/aluminum conductor, armored cables of sizes up to 6 sq.mm conductor.

Terminals shall be of stud or clamp type. The internal wiring shall be completed by the manufacturer by means of stranded copper wire of minimum 2.5 sq.mm size and terminated on the terminal block. Terminal blocks shall be mounted with minimum two fixing screws.

Mounting facility and conduit knock-outs for the luminaires shall be provided.

Earthing

- Each luminaire and control gear box shall be provided with an earthing terminal.
- All metal or metal enclosed parts of the luminaire/control gear box shall be bonded and connected to the earthing terminal so as to ensure satisfactory earthing continuity.

Painting/Finish

- All surfaces of the luminaire/control gear box housing accessories shall be thoroughly cleaned and degreased. It shall be free from scale, rust, sharp edges and burrs.

The luminaire housing shall be stove-enameled/epoxy stove-enameled-vitreous enameled or anodised as indicated under various types of fittings

Low/Medium/High bay LED Luminaire housing shall be die cast aluminium and anodized aluminium reflector with polyester powder coat finish or polyester white paint finish. Diffuser shall be made of Polycarbonate material. Luminaire shall have heat sink for better thermal dissipation

Bulkhead LED Luminaire housing shall be die cast aluminium with front cover of poly carbonate diffuser.

12.7.2 Flood Light Luminaire

The Flood light LED luminaire shall be housed in die cast aluminium and corrosion resistant powder finish and shall have toughened class diffuser with integral driver.

Flood lights LED shall be used for peripheral lighting outside the pumphouse building.

The Flood light LED luminaire shall be housed in die cast aluminium and corrosion resistant powder finish and shall have toughened class diffuser with integral driver.

12.7.3 Solar Street Light System

Stand alone Solar street light with LED shall be used for outdoor street lighting pole.

For LED Lighting, the street Light fixture shall be made up of high pressure die-cast aluminium alloy with toughened diffuser with anodised aluminium reflector. The Driver shall be of integral. The fixture shall have excellent heat dissipation through cooling fins on housing. The housing shall be complete with LED, driver and accessories pre-wired-up to terminal block in connector compartment. The degree of protection shall be IP65 or better.

Basically Stand alone systems will be installed in the field. There is a pole which has Solar Module on the top, a light fitting, a Battery box with electronics and Battery in it.

The Standalone solar lighting systems shall comprise:

- Solar module ,
- Battery box , charger
- Controller,

- Light dome are fixed in a single pole itself.

The battery is Charged only by SOLAR MODULE. The octagonal poles are installed at site and civil works foundations are required to ensure their rigidity. The specification of Solar

Module and Battery depends upon the Wattage of light dome and number of hours of illumination required.

Solar module shall convert solar energy into electrical energy and store into the battery. During the night time stored energy shall be converted to AC using efficient inverter and shall be supplied to the street lights.

The system shall be powered from the normal grid supply in case of cloudy days or in case of insufficient day light to charge the battery.

All equipment and accessories along with all safety items shall be provided by the contractor (if not considered) to complete the successful execution as per IS, IEC and Indian Electricity Act.

12.8 Lighting Panels / Lighting DB

Constructional Features of boards and panels shall be in accordance with General Electrical Specifications of this volume. The hinged door of each unit shall be interlocked so as to prevent opening of the door when the switch is ON and to prevent closing of the switch with the door not fully closed. However, a device for by-passing the door interlock shall be provided to enable the operation of the switch with the door open, when necessary, for examination/maintenance. For wall mounting 1-phase ways lighting panels when provided with MCBs, a hinged, latched front door shall be provided with key-locking facility and a slotted bake lite sheet shall be provided inside. Only the MCBs operating knobs or the fuse cap covers shall project out of the bake lite sheet slots for safe operation and neat appearance.

Incomer to lighting panels shall be provided with TPN MCCB/ TPN MCB with RCCB/ELCB. ELCBs shall be required for all lighting circuit, wall mounted switch Boards, power plugs distribution boards etc.

All accessible live connections/metals shall be shrouded and it shall be possible to change individual fuses, switches, MCCB / MCBs from the front of the boards/panels without danger of contact with live metal.

For floor mounting type distribution boards, adequately sized mounting channels shall be supplied and for wall/column/structure mounting type panels suitable mounting straps shall be provided.

Adequate interior cabling space and suitable removable cable entry plates shall be provided for top/bottom entry of cables through glands and or conduits as required.

Necessary number of glands to suit the specified cable sizes shall be provided. Cable glands shall be double compression screwed on type and made of chrome plated brass.

Earth bus shall be provided throughout the panel length. Two earthing terminals shall be provided on the both side of panels.

All sheet steel parts shall undergo rust-proofing process which should include degreasing, de-scaling and a recognised phosphating process. The steel works shall then be painted with two coats of Zinc - chromate primer and two coats of final stove-enamelled finish paint of specified colour.

Busbars

(a) Busbars shall be in accordance with General Electrical Specifications of this volume

The neutral bus of the main 3 phase, 4 wire distribution board shall be rated for full short circuit rating of main busbar. The neutral bus should have sufficient terminals and detachable links for full number of single phase / 3 phase 4 wire outgoing lighting circuits.

(b) Panels/Boards' Component Equipment

1. SFU/MCCB/MCBs/RCCBs shall be hand operated, air break, quick make, quick break type conforming to applicable standards.
2. The feeders shall be provided with MCB/MCCB for overload/short circuit protection. RCCBs of suitable rating shall be provided for earth leakage protection.
3. Switch shall have provision for locking in both fully open and closed positions. MCBs/RCCBs shall be provided with locking facility.

(c) Indicating Instruments , Meters and lamps

This shall be in accordance with General Electrical Specifications of this volume

(d) Internal Wiring

This shall be in accordance with General Electrical Specifications of this volume

12.9 Labels & Diagram Plate

This shall be in accordance with General Electrical Specifications of this volume

12.10 Light Control Switches

Light control switches of ratings and types, i.e. decorative/industrial shall be supplied as required. The switches shall be suitable for use on 240 V, 1 Ph, 50 Hz supply.

Switches shall be of flush type for mounting behind an insulated plate or incorporated with a switch plate for mounting flush with the surface of wall or switch box/suitable enclosure. The switch box/enclosure may be recessed into or mounted on a wall as per the requirement of project layouts.

The enclosure shall be as per constructional features mentioned in General Electrical Specifications of this volume and suitable for the Requirements.

12.11 Receptacle Units

Receptacle units shall consist of socket outlet with associated switch and plug. The socket outlet and switch or MCB shall be mounted flush with the front cover plate of the box and the unit shall be complete with gasket, cable glands, cable lugs and earthing terminal with washers and nuts. The box may be recessed into or mounted on a wall as per requirements of project layouts. The receptacle units shall be suitable for 240 V, 1 ph - N, 50 Hz/415 V, 3 Ph - N, 50 Hz supply as required. .Single phase receptacles shall be associated with a switch/MCB of same current rating , Three phase receptacles shall be associated with a TPN switch housed in the same enclosure and the receptacle shall become live only when the associated switch/MCB is in “ON” position. The plugs shall be provided with cord grips to prevent strain and damage to conductors/wires at connection and entry points.

12.12 Lighting and Receptacle Wiring

The wires for wiring in lighting system shall be 650/1100 V, 4/C PVC insulated, armoured with stranded copper conductors.

The minimum area of conductors shall be 2.5 sq.mm. for light fittings and 5A Receptacles and 4 sq.mm for receptacles rated 15 A and above.

The wires shall be coated white for phase/positive of d.c. and black for neutral/negative of d.c.

12.13 Conduits

Rigid steel/non-metallic conduits and their associated fittings as required shall conform to applicable standards. The minimum size of conduit shall be 20 mm for surface installation and 25 mm for concealed installation.

Steel conduits shall be seamed by welding and hot dip galvanised. They shall be supplied in standard lengths of 5 m.

Supply of conduits shall include all associated fittings like couplers, bends and tees as required for lighting system installation work.

12.14 Junction Boxes

Junction boxes with terminals shall be supplied for branching and terminating lighting cables when required for outdoor areas, 3 phase receptacles etc.

The junction boxes shall be dust and vermin proof and shall be fabricated from 1.2 mm to 2 mm CRCA sheet steel and shall be complete with removable cover plate with gaskets, two earthing terminals each with nut, bolt and washer. Boxes shall be additionally weather proof.

The boxes shall have provision for wall, column, pole or structure mounting and shall be provided with cable/conduit entry knock outs, terminal blocks, HRC fuses as required.

The terminal blocks, with specified number of terminals, shall be mounted securely on brackets welded to the back sheet of the box. The terminals shall be 650 V, grade, one piece construction complete with terminals, insulation barriers, galvanised nuts, bolts and washers and provided with identification strips of PVC. The terminals shall be made of copper alloy and shall be of box clamp type.

The boxes shall be hot dip galvanised/painted with one shop coat of red oxide zinc chromate primer followed by a finishing coat of paint.

12.15 Lighting Poles

Lighting poles for outdoor lighting shall be of 7m height Octagonal lighting poles construction as per applicable standard. The supply of poles shall be complete with fixing bracket/necessary pipe reducer for fixing the fitting and also include the necessary associated pole mounted junction boxes.

All the Octagonal Poles shall be designed to withstand the maximum wind speed as per IS 875. The top loading i.e. area and the weight of fixtures are to be considered to calculate maximum deflection of the pole and the same shall meet the requirement of BS EN 40-3-3:2013.

The pole shaft shall have octagonal cross section and shall be continuously tapered with single longitudinal welding.

All octagonal pole shafts shall be provided with the rigid flange plate of suitable thickness with provision for fixing minimum 4 foundation bolts. The base plate shall be fillet welded to the pole shaft at two locations i.e. from inside and outside. The welding shall be done as per standard approved process.

The materials of the pole as follows:

Pole - Conforming to grade S355J0,

Base Plate: - Fe 410 Conforming to IS 226/ IS 2062,

Foundation Bolts: - 6.8 Gr. as per IS 1367,

Pole Sections: - The Octagonal Poles shall be in single piece with single longitudinal welding joint,

Galvanization: - The poles shall be hot dip galvanized as per IS 2629 / IS 2633 / IS 4759 and BSEN ISO 1461 standards with average coating thickness of 65 micron. The galvanizing shall be done in single dipping. The zinc Ingot raw material shall be 99.99% pure and procured from reliable sources with Quality Test Certificates.

The pole manufacturing & galvanizing unit shall be ISO 9001: 2000 & ISO 14001 certified to ensure consistent quality & environmental protection.

The poles shall have integrated Junction box with openable door of adequate size (Not less than 500mm length) at the elevation of 500 mm from the base plate. The door shall

be hinged type with mechanical interlock, dust proof, weather proof and vandal resistant and shall ensure safety of inside connections and components. The door shall be flush with the exterior surface and shall have suitable locking arrangement. The pole shall be adequately strengthened at the location of the door to compensate for the loss in section.

The door of the Junction Box shall permit clear access to the components inside viz., termination strips, connectors, MCBs, cables etc. There shall also be suitable arrangement for the purpose of earthing.

Electrical connections - Four way connectors shall be provided along with Slide lock suitable for connecting 1.1 kV grade, 4 core X16 sqmm Al cable. It shall also house1 no. 6 amps DP MCB,2.5 sqmm connectors for looping with 2.5 Sqmm Copper wires for connecting to the luminaries through 0.75kV grade, 3 core X 2.5 mm^2 PVC insulated copper conductor flexible un-armoured Cable from the terminal block to the fixture within the pole. All the cables laid through the pipe shall be without any joint.

Two nos. Earth Boss shall be provided at the bottom of the pole or on base plate (diagonally opposite) suitable for connecting 25X6 mm GI earth strip earthing of the poles. Similar Earth Boss suitable for connecting 4 sqmm copper wire shall be provided on the control plate inside the Junction Box for earthing of the electrical components.

Two nos. 50 mm NB HDPE sleeves of suitable length shall be provided through the foundation up to foundation top.

One earth pit shall be provided per hundred (100) meters. An earth grid of 25x6 sqmm GI Strip shall continuously run along the ROW with the cable. Light poles shall be connected to the earth grid with the two distinct earth boss on the pole.

M20 concrete foundations shall be provided for all the poles. The Poles shall be bolted on a pre-cast foundation with minimum four foundation bolts for greater rigidity.

12.16 Tests

Type tests, acceptance tests and routine tests for the lighting fixtures and accessories covered by this specification shall be carried out as per the relevant standard for the respective fixtures and their accessories.

The manufacturer's type and routine test certificates shall be submitted for tests conducted as per relevant standards for the fixtures and accessories.

13. Safety Equipment

13.1 General

Safety procedures and practices while doing electrical works shall conform to IS 5216.

Following safety equipment shall be provided at each substation location:

1. Sand Bucket Extinguishers:

Two sand buckets of adequate capacity shall be installed near each transformer area at an approachable location.

2. Dry CO2 Fire Extinguishers:

Dry carbon dioxide types portable fire extinguishers, of minimum 5 kg capacity, shall be provided in each transformer area, panel room, Pump house and whenever it is required.

3. Insulating mats as per the appropriate voltage grade, IS marked, as per electricity rules. Shall be running in front along the length of the switchboard on the floor area of switchgear room. Insulating mats shall conform to IS 15652.

4. Shock Treatment Charts

2 nos. Shock treatment charts in English & local language (Marathi & Hindi) as per relevant standards shall be provided in each panel room at an approachable location.

5. Danger Plates

"DANGER" plates shall conform to IS 2551 and indicate relevant voltage grade written in English and local language (Marathi & Hindi) shall be provided at all accessible sides of the following locations-

- All Switchgear room, Transformer Area & pump house Area
- Set of insulation class wise hand gloves and earthing rods.

All Electrical Installations shall be duly approved by Chief Electrical Inspector to Government (CEIG) and other statutory authorities. The contractor shall bear the cost of the same.

14. Particular Electrical Specification

14.1 Power Receiving System

- Voltage : 22 kV nominal, 24 kV highest
- Frequency : 50 Hz
- Connection : 3 phase, 3 wire
- System Earthing : Solidly earthed (Effectively earthed)
- kV system maximum fault Level: 31.5 kA/ 1sec

14.2 MV Power Distribution System within the Plant

- Voltage : 6.6 kV nominal, 7.2 kV highest
- Frequency : 50 Hz
- Connection : 3 phase, 3 wire
- System Earthing : Resistance earthed (Non-effectively earthed)
- kV system maximum fault Level: 31.5 kA/1sec

14.3 LV System

- Voltage: 415 V nominal, 440V highest
- Frequency: 50 Hz
- Connection: 3 phase, 4 wire
- System Earthing Solidly earthed

415V Maximum fault Level: 50 kA r.m.s. for 1sec

14.4 Control Voltage for LV motor starters

- Voltage: 110 V AC
- Phases: 1
- Frequency: 50 Hz

14.5 Instrumentation Power supply, lighting & Space heating supply

- Voltage: 240 V
- Phases: 1
- Frequency: 50 Hz

14.6 DC control voltage (for 22kV, 6.6 kV switchgear and DCDBs)

- Voltage: 110 V DC
- Wires/Earthing: 2 wire / unearthed

INSTRUMETATION & CONTROLS (I&C)

TECHNICAL SPECIFICATIONS

Table of Contents

SECTION 1 – INSTRUMENTATION & CONTROLS

PART 1 - GENERAL

1.01 Governing Conditions:

A. The General Conditions, Special Conditions, Tender Forms, Instructions to Contractor and the requirements of the Specifications and all Addenda apply to and govern each section of this division.

B. This section covers the general requirements and shall be read in conjunction with all other sections in this division.

1.02 Work Included:

A. The work to be completed consists of the design, manufacture, assembly, supply, shop testing, calibrating, delivery, installation, commissioning and providing guarantees for the complete control and instrumentation system as specified and as shown in the Drawings.

B. More specifically, this also includes:
   1. All instruments, devices and panels as specified.
   2. Shop fabrication of panels, including instruments, devices and cabling.
   3. Supervision, calibration and loop check for instrumentation systems in the field to the Engineer's satisfaction. Complete loop checks and submission to the Engineer of a report on verification and results of loop checks, including details of calibration and settings of the equipment.
   4. Conceiving, developing, installing, testing and commissioning of application software so that the plant is controlled as intended.
   5. Provide SCADA systems as specified in Section 3.

C. Process Narratives and the Drawings are intended to provide basic information of the systems required and shall serve as a guide in designing the systems. Provide detail designed, complete control systems including, but not limited to: field wiring, cable/conduit layouts, device installation and calibration settings, control system architecture, communications and loop drawings, catalogue extracts and shop drawings for all equipment and panels.

D. Refer Mechanical and Electrical specifications to ensure the completeness of the installation of control items and that they are compatible with the control and operation intentions of the design.

E. Working drawings, including field installation drawings, field cabling, product descriptions with catalogues and literature shall be submitted for approval before any

equipment is procured. Submit shop drawings showing all relevant information including descriptive data, schematic and interconnecting wiring diagrams, design drawings, specification sheets, field calibration sheets, dimensions and installation details.

F. The intention of this section is to provide instrumentation and control systems that:
   1. shall monitor and control process parameters and equipment included in this Contract.
   2. shall be ready for connection to IPS SCADA system through 1 No. SCADA database server with integral Web server application, 1 No. SCADA Historian server, 1 No. Operator Station, 1 No. Laptop 17" size equipped with Operator-cum- Engineering Station license and other necessary softwares.
   3. shall be able to communicate with future WwTF SCADA signals (communication hardware provision only)

1.03 Co-ordination:

A. Before installing work included in this division, co-ordinate fully with the works in other divisions. If work is installed without proper co-ordination with other works, the Engineer may direct that such work be removed, relocated and/or modified as necessary. Comply promptly with any Engineer's requests. Complete any corrective work, as directed by the Engineer.

1.04 Submittals:

A. Submit shop drawings, product data sheets and other documents for items in accordance with following list.
   1. Deviations to technical specifications
   2. Process and Instrumentation diagrams
   3. Automation system configuration
   4. List of Alarms/Annunciations
   5. Interconnection cabling block diagrams
   6. Control panel layouts
   7. Instrument Schedule/List
   8. Instrument data sheets
   9. Instrument Hook-up drawings
   10. Instrument calculation reports
   11. Instrument calibration reports
   12. I & C schematics
   13. Instrument loop drawings

14. I & C wiring and connection diagrams
15. I & C cable lists
16. Field wiring/conduit cabling diagrams
17. Instrument location drawings
18. Certified dimensional drawings
19. Mounting details
20. Earthing details
21. Functional logic diagrams
22. User manuals
23. Level 1 functional specifications
24. Level 2 computer interface data tables
25. PLC and operator interface documented programme
26. I/O schedules (AI/AO/DI/DO)
27. SCADA/HMI Screens details
28. Shop test / platform test programme
29. Shop test / platform test reports
30. Demonstration software
31. Software lists
32. Programming tools manual

B. Refer to individual sections of this Document.

C. Assemble and submit operating and maintenance data containing booklets, As-Built Drawings, instruction sheets etc. issued by the suppliers and relating to the equipment intended to be installed under this Section and necessary for the calibration, maintenance, repair or operation of the equipment.

1.05 Codes and Standards:

C. The applicable standards govern the materials and workmanship employed in the manufacture of all equipment includes:

1.	BS 89-2:1990, EN 60051-2:1989, IEC 60051-2:1984	Direct acting indicating analogue electrical measuring instruments and their accessories.
2.	BS 1646-1:1979, ISO 3511/I-1977	Symbolic representation for process measurement control functions and instrumentation. Basic requirements.
3.	BS 4675-2:1978, ISO 2954-1975	Mechanical vibration in rotating machinery. Requirements for instruments for measuring vibration severity.
4.	BS 5863-1:1984, IEC 60381-1:1982	Analogue signals for process control systems. Specification for direct current signals.
5.	BS 5863-2:1980, IEC 60381-2:1978	Analogue signals for process control systems. Specification for direct voltage signals.

6.	BS 1042 (Various)	Measurement of fluid flow in closed conduits.
7.	BS 1553 (Various)	Specification for graphical symbols for general engineering.
8.	BS 3680 (Various)	Measurement of liquid flow in open channels.
9.	BS 3693:1992	Recommendations for design of scales and indexes on analogue indicating instruments.
10.	BS 5308 (Various)	Instrumentation cables.
11.	BS 5515	Documentation of Computer Based Systems.
12.	BS 6739:1986	Code of practice for instrumentation in process control systems: installation design and practice.
13.	BS 7165	Recommendation for Achievement of Quality in Software.
14.	BS EN 837-1:1998	Pressure gauges. Bourdon tube pressure gauges. Dimensions, metrology, requirements and testing.
15.	BS EN 50081	Electromagnetic Compatibility.
16.	BS EN 60073:2002	Basic and safety principles for man-machine interface, marking and identification. Coding principles for indicators and actuators.
17.	BS EN 60529:1992	Specification for degrees of protection provided by enclosures (IP code).
18.	BS EN 60584-1:1996, IEC 60584-1:1995	Thermocouples. Reference tables.
19.	BS EN 60654-1:1993, IEC 60654-1:1993	Industrial-process measurement and control equipment. Operating conditions. Climatic conditions.
20.	BS EN 60751:1996, IEC 60751:1983	Industrial platinum resistance thermometer sensors.
21.	BS EN 60770-1:1999, IEC	Transmitters for use in industrial-

	60770-1:1999	process control systems. Methods for performance evaluation.
22.	BS ISO 11631:1998	Measurement of fluid flow. Methods of specifying flow meter performance.
23.	IEEE 472-1974	Surge protection.
24.	IEEE 60587	Power Supply Surge Protection.
25.	ANSI/ISA-7.0.01-1996	Quality Standard for Instrument Air.
26.	ANSI/ISA-18.1-1979 - (R1992)	Annunciation Sequences and Specifications.
27.	ANSI/ISA-50.00.01-1975 (R2002)	Compatibility of Analog Signals for Electronic Industrial Process Instruments.
28.	ANSI/ISA-51.1-1979 - (R1993)	Process Instrumentation Terminology.
29.	ISO 3511	Process measurement control functions - instrumentation symbolic representation.
30.	ISO 9000 and 09004	Quality Systems.
31.	ISO 9075 (BS 6964)	Structured Query Language (SQL).
32.	ISA-5.1-1984 - (R1992)	Instrumentation Symbols and Identification.
33.	ISA-5.4-1991	Instrument Loop Diagrams.
34.	ISA-26-1968	Dynamic Response Testing of Process Control Instrumentation.
35.	ISA-37.1-1975 - (R1982)	Electrical Transducer Nomenclature and Terminology.
36.	ISA-37.3-1982 - (R1995)	Specifications and Tests for Strain Gage Pressure Transducers.
37.	IEC 61131-3	Programming Languages for Programmable Controllers.
38.	IEC 61158-2	Communication Protocols
39.	IEC-8705101	Modbus Protocol Conversion
40.	IEC-62382	Electrical and Instrumentation Loop Check
17.	BS 1042 (Various)	Measurement of fluid flow in closed conduits.
18.	BS 1553 (Various)	Specification for graphical symbols for

		general engineering.
19.	BS 3680 (Various)	Measurement of liquid flow in open channels.
20.	BS 3693:1992	Recommendations for design of scales and indexes on analogue indicating instruments.
21.	BS 5308 (Various)	Instrumentation cables.
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20.	BS EN 60751:1996, IEC 60751:1983	Industrial platinum resistance thermometer sensors.
21.	BS EN 60770-1:1999, IEC 60770-1:1999	Transmitters for use in industrial-process control systems. Methods for performance evaluation.
22.	BS ISO 11631:1998	Measurement of fluid flow. Methods of

		specifying flow meter performance.
23.	IEEE 472-1974	Surge protection.
24.	IEEE 60587	Power Supply Surge Protection.
25.	ANSI/ISA-7.0.01-1996	Quality Standard for Instrument Air.
26.	ANSI/ISA-18.1-1979 - (R1992)	Annunciation Sequences and Specifications.
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38.	IEC 61158-2	Communication Protocols
39.	IEC-8705101	Modbus Protocol Conversion
40.	IEC-62382	Electrical and Instrumentation Loop Check

A. Where the provisions of the pertinent codes and standards conflict with these Specifications and Drawings or with each other, comply with the more stringent provisions.

B. Use the latest issue of Standards.

1.06 Guarantee:

A. Obtain all the necessary warranties and guarantees as required to guarantee that the entire control and instrumentation system will perform as herein described. Be responsible for all suppliers' engineering required, including the necessary wiring configuration, preparation of shop drawings and site visits for calibration and/or confirmation of proper installation.

1.07 System Integrator:

A. The main contractor shall obtain approval from the Employer for the proposed automation works system integrator before commencement of control system related documents and drawings submission.
B. The system integrator is responsible for providing the instrumentation system and PLC and SCADA programming. However, ultimate responsibility of a smooth operation of IPS remains on Bidder.
C. Good track record, reputation, understanding of the processes to be controlled, experience with similar projects and availability for support are essential.

PART 2 - PRODUCTS

2.01 General:

A. The entire control system is to operate automatically on an electronic basis, principally through the use of programmable microprocessor-based equipment which can be revised, reprogrammed and reset digitally without the need for hardware changes, additions, rewiring or mechanical adjustments.

B. Provide all items in conformity with the following particulars indicated for each item: tag, item description, Contractor's scope, power requirements, power source, applicable specification, signal types, IO wiring block configuration, control panel to which signal wires are connected, service and pipe size, process and calibrated ranges, set-points, electrical and mechanical installation drawings, system drawings showing the devices, layout drawings indicating physical locations and notes or special instructions. The list may also include items which are supplied under other Divisions.

C. The ranges shown are preliminary only and will be adjusted to suit the actual equipment supplied. Calibration ranges and set points may vary during the review of the shop drawings.

D. For service legend see Drawings.

E. Provide all required current isolators, signal conditioners etc. and any other

instruments and appurtenances which may or may not be shown, but which are required for the entire control and instrumentation system to operate as intended by these Specifications and as designed.

F. All devices shall be subject to the approval of the Engineer.

G. The Contractor shall be responsible for relocation of materials and/or equipment as directed, provided that the changes are made before installation and do not necessitate the purchasing of additional material.

H. As a minimum standard, unless specified otherwise, provide each instrument with corrosion-resistant mechanism and enclosed in NEMA 4X casing, suitable for mounting at the locations and by the method shown on the Drawings or as indicated by the Supplier. Where applicable, upgrade all items to equal the NEMA rating of the related area.

I. Areas of a hazardous nature are classified as noted on the Drawings. Reference may also be made to NFPA 820 latest edition. Comply with Indian Electricity Code for all electrical work and equipment enclosures in hazardous areas.

J. NEMA 3S and 4 enclosures for all equipment mounted outdoors as a minimum standard, unless specified otherwise, suitable for operating in temperatures from 0 to +50°C. Design the control systems to operate satisfactorily under normal electrical supply, including transient periods under changeover conditions. Provide instrument components that have ample margin to withstand transient and other surge voltages which may occur.

K. Unless specifically stated otherwise, or the supplier can demonstrate it is not necessary, provide all readouts, indicators, recorders etc. with linear, metric unit scales. All final units, ranges, set points, colors etc. will be finalized during the working/shop drawings review.

L. Fully pre-wire and pre-pipe all instruments and control elements in the factory and provide terminals, terminal blocks and taps suitable for direct connection in the field.

M. Meet the accuracies specified for all instruments. If a supplier cannot meet any of the accuracies called for, clearly state so in the shop drawing submission and state the highest accuracy which the instrument can consistently meet.

2.02 Wiring:

A. For analogue and low voltage signal wiring, use stranded copper, shielded twisted pairs except where indicated otherwise.

B. For control circuit wiring, use stranded copper, except where otherwise indicated.

C. For wiring, refer to Electrical specification

2.03 Surge Protectors:

A. Provide surge protection devices – of suitable capacity and level – on all the following circuits in panels and to each computer workstation:

1. Power supply lines, including externally powered IOs;
2. Signal and control circuits connected to devices located remotely, when the cable run, or the device is exposed to weather conditions;
3. Network communication lines (copper);

B. Provide surge protection device(s) – of suitable capacity, level, and enclosure – at the field instruments, on their power and signal circuits, if the incoming cable runs are exposed at any point to the weather conditions.

C. Connect the surge protector to the ground with a low impedance wire on the shortest and straightest run, as per manufacturer's requirements.

D. Coordinate the selection of surge protection devices with similar devices installed in the plant power distribution system.

2.04 Uninterruptible Power Supplies (UPS):

A. Provide UPS which can supply 230 V AC to the required instruments and devices for when their main 230 V power supply fails.

B. The required loads are the ones required to maintain the data acquisition and display capacities of the control system during a local or general power outage.

C. Supply and install one UPS per Control Panel containing a PLC

D. Include two dry contact outputs in each UPS, for connection to the plant PLC. Contacts to be as follows:

1. Normal Power or UPS Power
2. Low battery

E. UPS shall provide **120 minutes** back up at full load of auxiliary power when

230 V AC source fails.

F. Battery shall be sealed maintenance free (SMF) lead acid type.

2.05 General Instrumentation Specification

A. PLC System

PLC Shall be Modular rack based and the interruption shall be limited to the subject card related inputs/ outputs only. Point IO/Slim IO's are not acceptable. It shall be possible to add modules or add new nodes without need of stopping the controller as well as changing the application or variables. Open protocols to be supported by PLC system for third party interface shall be modbus TCP/IP, Ethernet Connectivity etc. Power supply redundancy on IO racks with External power supply is not acceptable. User Memory shall be minimum 8 MB with expansion capacity. PLC system shall comply to IEC 62443 standards. Optical or Galvanic isolation for Digital and Channel to Channel isolation for all Analog channels is required.

B. SCADA

The SCADA shall be suitable for day to day operation by non-computer literate personnel in the monitoring and operation of Intermediate Pumping Station. SCADA shall be provided at IPS Control room. The SCADA System shall be designed to store, archive and retrieve complete plant operational data for at least three (3) months. This shall be provided in addition to the Historian software being provided. The Historian software shall be designed and configured on a minimum to accept the number of tags similar to the SCADA software. The Historian software and server system shall be designed and configured to store data for a minimum of 5 years. The SCADA system shall be provided with a Historian system for historical data archiving and retrieval. SCADA system shall retrieve information from PLC over **DNP3.0 or equivalent IEC Protocol** and transforms raw process data into analyzed user-friendly information.

Commented [SNC1]: add word "**or equivalent IEC Protocol**"

C. HMI

The HMI shall be with colour screen and touch screen capabilities. The PLC panel shall be equipped with a minimum 12" panel HMI. The HMI shall be suitable for day to day operation by non-computer literate personnel in the monitoring and operation of the IPS works. It shall be possible to view and acknowledge the alarms and view setpoints for the particular process from the HMI. The HMI shall provide efficient and safe operation of the process plant by detecting alarm and error conditions, alerting the operator to these conditions both visually and audibly, monitoring all important system parameters and providing facilities for plant optimization. The system will allow operators, technicians to issue commands to change system parameters, start and stop equipment, provide configuration tools and operate diagnostic facilities. The System shall perform all the necessary functions for the optimum monitoring, control and operation of the particular system. HMI unit along with software packages shall be considered, and also those software packages and Hardware shall be compatible with TCP / IP protocols as well as OPC communication (Open Standard Communication).

D. Process Instrumentation

i. General

Instrumentation system shall be designed, manufactured, installed and tested to ensure the high standards of operational reliability. All electronic components shall be adequately rated, and circuits shall be designed so that change of component characteristics shall not affect plant operation. All instrumentation equipment shall be new, of proven design, reputed make, and shall be suitable for continuous operation.

Unless otherwise specified, all instruments shall be tropicalized. The outdoor equipment's shall be designed to withstand tropical rain. Wherever necessary space heaters, dust and water proof cabinets shall be provided. Instruments offered shall be complete with all the necessary mounting accessories.

All instruments shall be from the country of origin as indicated in the approved vendor list elsewhere in this specification.

All instruments shall be offered for inspection & testing before dispatch, at Manufacturers Factory works where the instrument has been manufactured.

Electronic instruments shall utilize solid state electronic components, integrated circuits, microprocessors, etc., and shall be of proven design.

No custom-made hybrid type integrated circuits shall be used.

Unless otherwise stated, overall accuracy of all measurement systems shall be ±0.5 % of measured value, and repeatability shall be ±0.5%.

Unless otherwise specified, the normal working range of all indicating instruments shall be between 30% and 80% of the full-scale range.

On resumption of the supply following a power failure the instruments and associated equipment shall start working automatically.

The instruments shall be designed to permit maximum interchangeability of parts and ease of access during inspection and maintenance.

Unless otherwise stated, field mounted electrical and electronic instruments shall be weatherproof to IP65. All outdoor instruments shall be fitted with canopy to shield the instruments against the weather.

The instruments shall be designed to work at the ambient conditions of temperature, humidity, and chlorine contamination that may prevail but, in any case, not less stringent than those conditions detailed in the Project Requirements. Instruments shall be resistant to corrosion in the atmosphere in which they are expected to operate.

Lockable enclosures shall be provided for all the field mounted instruments.

All field instruments, and cabinets/panel mounted instruments shall have tag plates/name plates permanently attached to them. Details of proposed inscriptions shall be submitted to the Employer for approval before any labels are manufactured.

All coated parts of sensors shall be made out of non-corrosive material.

For all instruments installed in the field, surge protection devices (SPDs) shall be provided at both ends of the connecting cable for protection against static discharges / lightning and electromagnetic interference.

Individual pair screened, overall screened, armoured cables shall be used for analogue signals and armoured, overall screened cable shall be used for digital signal cables.

E. Flow Measuring Systems

Flow measuring system shall consist of flow sensor / transducers, flow computer and flow transmitter. Flow transducers shall be rugged in construction and shall be suitable for continuous operation. Flow transducers shall have waterproof construction and shall be suitable for installation in underground/above ground pipelines as per project requirement. To avoid the effects of disturbances in the velocity profile, a straight and uninterrupted run, upstream as well as downstream from the location of the flow sensor shall be provided in accordance with the requirements of the flowmeter manufacturer. The flow transmitter shall be suitable for field or panel mounting and shall accept an input from the flow sensor. It shall process the input signal and provide 4-20 mA dc output proportional to flow rate. The flow range shall be adjustable. A zero-span adjustment facility shall be provided for flow transmitter and indicator.

Flow measurement shall not be affected by physical properties of sewage viz., temperature, pressure, viscosity, density etc., within given limits. Contractor shall provide compensating electronic circuits if required. The overall accuracy of flow measuring systems shall be at least ±0.5 % of the measured value unless otherwise stated.

ii. Electromagnetic Flow Meter (Full Bore):

The Electromagnetic Flow Meters shall be installed for indication of flow rate and totalized flow in a transmission or distribution pipe system. The Electromagnetic Flow Meters shall withstand maximum working temperature and working pressure shall be as per process requirement. Full bore electromagnetic flow meters shall be designed, manufactured and calibrated to ISO standard. The meter shall be manufactured to highest standard available for mag-meters. The accuracy shall be inclusive of linearity, hysteresis, and repeatability, temperature and pressure effects. The meter assembly shall operate within a range of 0.3 m/sec to 5 m/sec and pressure rating shall be as per process requirement to be constructed as follows

Meter tube shall have a constant nominal inside diameter offering no obstruction to the flow. Signal Converter shall be pulsed DC coil excitation type with auto zeroing. The signal converter shall be remotely mounted away from the meter. The converter shall indicate direction of flow and provide a flow rate indication and a total of flow volume for both forward and reverse directions.

The converter shall provide an isolated 4-20 mA output. The microprocessor-based signal converter shall have a self-diagnostic test mode and backlit display that continuously displays ‘Rate of Flow’ and ‘Total Volume’. The converter shall be compatible with Microsoft Windows and other software programs with built in terminal communication capabilities of RS 485, HART or other protocols for interface.

The converter shall be remotely mounted from the sensor and shall be supplied with all calibration complete for desired requirements. The converter cum transmitter shall be fully programmable from the front facia. The programming shall be user friendly, self-prompting menu driven.

All flow meters shall be offered for inspection & testing before dispatch at Manufacturers Factory where the instrument has been manufactured. QAP shall be

submitted which shall include functional testing and calibration at the manufacturer factory.

F. Level Measuring System

i. Ultrasonic Level Meters

Ultrasonic level measuring devices applied for liquid level measurement shall comprise a transducer, control unit and remote indicator. The transducer shall be suitable for flange or bracket mounting as required and shall be environmentally protected to IP68. It shall have ambient temperature compensation, adjustable datum setting facilities. The remote level transmitter cum indicator shall have IP54 ingress protection. The accuracy of the sensor shall be ± 0.25% or better. It shall be programmable with an integral programming keyboard and provide a digital display of the measured variable. It shall be provided with diagnosis facilities and shall provide an isolated 4 to 20 mA dc output signal proportional to the range of measurement. The design and application of ultrasonic level meters shall take into account the vessel or channel construction, the material, size, shape, environment, process fluid or material, the presence of foam, granules, size etc. The installation shall avoid any degradation of performance from spurious reflections, absorption, sound velocity variations, sensor detection area, temperature fluctuations, specific gravity changes and condensation. For applications where, spurious reflections are unavoidable the control unit shall be provided with facilities for spurious reflection rejection. If turbulence exists, shielding, stilling tubes or other measures shall be provided to avoid effects on the measurement.

ii. Radar Level Meters

Radar level transmitter shall be based on Frequency Modulated Continuous Wave (FMCW) Technology applied for liquid level measurement and shall comprise a transducer, control unit and indicator. The latest FMCW transmitters shall have a double surface handling function, which allows the user to select if the foam layer or liquid surface should be used as output. This enables the liquid surface to be measured rather than the foam layer in a tank. The transducer shall be suitable for flange or bracket mounting as required and shall be environmentally protected to IP66. The accuracy of the sensor shall be ± 0.1% of range or better. It shall provide isolated 4 to 20 mA dc output signal proportional to the range of measurement. The Transmitter display shall be digital with readout in engineering units, Alphanumeric backlit LCD, 2½ digits, Microprocessor based electronics. Reset facility shall be provided.

iii. Conductivity Level Switches

The electrodes used for conductivity level switches shall be stainless steel. Single electrode systems (one electrode per holder) shall be used (except where their use is impractical) with insulated electrodes such that only the tip of each electrode is exposed to the liquid at the operating level. Relay or control units operating with level electrodes shall have adjustable sensitivity. Electrodes for use in fluids of low or variable conductivity shall be fitted with conductivity discs. Where relay or control units are not mounted in control panels, they shall be provided with surface mounting enclosures with a degree of protection to IP52 for indoor locations or IP65 for outdoor locations.

G. Pressure Gauges, Switches and Transmitters

Pressure gauges shall comply with BS EN 837- Parts 1, 2 & 3. Pressure gauges, transmitters and switches shall have over range protection up to 1.5 times the maximum anticipated line pressure and have concentric scales. For especially arduous duty where the gauge is subject to pressure pulsations and/or vibration, it shall be provided with a glycerin filled dial and line snubbers shall be used. Bourdon-tube type differential-pressure gauges shall be capable of withstanding full line pressure on any side with the other side vented to atmosphere without damage to or effect on the calibration. No plastic material shall be used in their construction. Internal parts shall be of stainless steel, bronze or approved corrosion resistant material. The minimum diameter for round pressure gauges shall be 100mm unless specified otherwise or where the gauge forms part of a standard item of equipment. Unless specified elsewhere the accuracy for pressure gauges shall be ±1% of range or better, for diaphragm gauges ±1% of range and for differential gauges 1.5% of range or better. The zero and span of a pressure transmitter shall not change by more than 0.1% of the span per Celsius degree change in ambient temperature. After application for 10 minutes of pressure at 130% of maximum pressure, the change in zero and span shall not exceed 0.1% of the span. Pressure transmitters/switches shall have an accuracy typically better than 0.15% of span or better, depending on the application and shall be protected to IP67 or higher standard. Pressure transmitters shall provide a digital or 4mA to 20mA dc output proportional to the pressure range. Pressure gauges, switches and transmitters shall have primary isolating valves, 2- or 3-way valve manifold and vents, in such a way that it has the facility to calibrate the gauges or transmitters without removal. The nominal pressure values at which pressure switches operate shall be fully adjustable over the whole range of the instrument and the set value(s) shall be clearly indicated by means of a scale and pointer. Pressure monitoring shall be by a sensor suitable for the medium and pressure/level range. A transmitter shall be provided either integral with the transducer or separately mounted as per site requirement. The transmitter shall have provision for span and zero adjustment.

H. Temperature Instrumentation

i. Resistance Thermometers

Platinum resistance thermometers shall be used for temperature sensing up to 650 Degree C. Temperature sensors incorporated within motor winding shall be inserted during the winding process to ensure intimacy of contact. Platinum resistance thermometers shall be selected and used in accordance with BS 1041-3 and shall comply with BS EN 60751. Each element shall be artificially aged during manufacture. Terminal heads and amplifiers shall be designed for three-wire connections between head and amplifier. Platinum resistance elements shall be fully encapsulated in ceramic, and element and high temperature resistant lead wires shall be hermetically sealed. The associated resistance-to current converters shall have zero and span adjustments and input-output circuit isolation.

ii. Temperature Scanner

Temperature scanner shall be provided to display winding and bearing temperatures and detect high temperatures in order to generate alarm and tripping signals. Temperature scanner shall be installed near operating platform of respective Pump.

The temperature scanners shall be microprocessor based having communication port for connectivity to PLC system network. The temperature scanners shall have multiple channels and shall have facility to change the set points of each channel for alarm and tripping. Programming feature shall include grouping of multiple channels setpoints to generate individual and common alarm and trip contacts. The display shall be for channel number and temperature. Menu driven selection shall be provided for set-points for each channel. The input signals to temperature scanner shall be from industrial type Pt-100 resistance temperature detectors (RTD), embedded in the windings and installed on the bearings. The temperature signals generated in the temperature scanners shall be connected to the PLC system through suitable Modbus communication port / converter. The trip signal generated in the temperature scanners shall be hardwired to the MCC panel for instantaneous tripping of the motor. The trip signal shall be also connected as digital input to the PLC system.

I. The following general installation guidelines shall apply:

- Transmitters and transducers shall be mounted as near as practical to the measurement point.
- Instruments shall be readily and safely accessible from grade, permanent platforms or fixed ladders to facilitate ease of maintenance for the equipment.
- Supply power to instrumentation from the control panel to which information is reported for remote monitoring.
- Unless otherwise shown or specified, mount instruments 1.4 m above finished floors, grade or platforms. Allow for cabinet plinth/floor-pad heights when locating panel instruments.
- Do not mount instruments on vibrating structures (e.g. handrails), or on piping or near equipment that may induce vibration.
- Do not mount instruments below or directly adjacent to lines conveying corrosive chemicals or near sources of leakage or spillage.
- Install the instrumentation and auxiliary devices (including sensors) such that they are accessible for maintenance. Provide space between instruments and other equipment and piping for ease of removal and servicing. Install to ensure accessibility from grade without requiring staff to enter confined spaces.
- Ensure that instrument displays are properly oriented for easy viewing.
- Any instrument that is not easily accessible for operation or maintenance, and any indicator that is not easily and readily visible, must be relocated as directed at no charge to the contract.
- Follow additional installation requirements as recommended by individual instrument manufacturer.
- Follow the Manufacturer’s recommendations for surge suppression on inductive loads.
- Surge protection devices (SPDs) shall be suitable for withstanding the surge arising out of high energy static discharge / lightning strikes and protect the instrument to which it is connected against damage. SPDs shall provide protection through the use of quick acting semiconductors like Tranzorb, zenerdiodes, varistors and an automatic disconnect and reset circuit. SPDs shall be passive and shall require negligible power for operation. During the occurrence of a surge it shall clamp on the allowable voltage and pass the

excess voltage to the ground. The SPD shall be self-resetting to minimize the down time of the measurement loop.

- SPDs shall be provided to protect devices transmitting and receiving analogue and digital signals derived from field devices located outdoors. The surge protection device shall be rated for surge rating of 10 KA.

PART 3 - EXECUTION

3.01 General:

A. Prepare, submit and maintain on site an I&C construction tracking form.

B. Where applicable, be responsible for verifying all measurements and details of the equipment and structures necessary for the proper fitting and connecting of the new equipment, before proceeding with the work. Any discrepancies between the Drawings and work will be referred to the Engineer. Be responsible for the proper fitting of the work and make such changes as necessary and directed by the Engineer.

C. Comply with all applicable municipal regulations and by-laws.

D. Be responsible to obtain all necessary permits, licenses, certificates and approvals.

3.02 Engineering:

A. Design and co-ordinate work pertaining to the various parts of the control and instrumentation system, to be mutually compatible and to function with the minimum of interruption or failures. Assume system design and supervision responsibility and engineer all components and all component connections to operate the system smoothly.

B. Assign a project manager responsible for the detail design, co-ordination and site supervision of the work and for meeting with the Engineer to study the Specifications, in order to establish that all parties concerned are in agreement on the intent of the system.

C. Prepare a set of preliminary drawings, showing the design of the system. Meet the Engineer to discuss the design, including process instruments and technical aspects, the process equipment to be controlled, the layout and components of process and equipment control panels. Prepare all field wiring diagrams.

D. Submit working drawings for all items. These will generally include:

1. Equipment identification name tags

2. Materials of construction and equipment configuration.
3. Equipment type/model, dimensions and weights.
4. Performance and operating characteristics, including calibrated ranges and set-points.
5. Complete bill of materials.
6. Wiring and interconnection schematic.
7. Application software documents as per Section 3.

E. After completion of detail design and all components of the system have been agreed upon, prepare final working drawings packages for review by the Engineer. Fabrication shall not commence until this review has been completed and final submission of reviewed working drawings has been returned to the supplier.

F. Provide on-site engineering and supervision of all equipment during its installation. Technical supervisions required at all times while equipment is being installed.

G. Take responsibility for the correctness of the installation.

H. Use all necessary test equipment to check out field wiring, equipment connections and all other parts of the system to determine whether or not the system is being installed correctly.

3.03 System Testing:

A. Arrange for and co-ordinate Factory Acceptance Tests (FATs) and Site Acceptance Tests (SATs). The scope of work described herein is a minimum requirement.

B. Thoroughly test the control and instrumentation system equipment in the shop for both individual unit operation and in simulation tests as a control system. Perform such tests before FATs, SATs and shipment.

C. Submit a detailed test procedure outlining methods and items to be included in the test. The Engineer reserves the right to modify the procedure to ensure that all items are included.

D. The Engineer reserves the right to witness any FAT and SAT. Provide at least (5)five working days notice to Engineer about the intent of conducting such tests indicating the time and venue.

E. Demonstrate each test to the Engineer’s satisfaction, the proper operation, calibration and installation of all systems (loops, control circuits and monitoring etc.), as per intent of this Contract.

F. Any failure during individual testing will result in a complete recheck after the failure is corrected.

G. On completion of the tests and examinations, submit signed copies of reports showing the results of inspections, operation, adjustments and testing.

H. The report shall also detail the methods and adjustments made, give quantitative results where applicable and make recommendations on the procedures to be followed to ensure proper maintenance. A copy of the report shall be included with each copy of the maintenance manuals.

I. The FATs will demonstrate that all panels, devices and programmable equipment are capable to perform as required and shall be completed at the control system supplier's factory. The test criteria shall consist of:

1. A review and inspection of the control panels for conformance with the Contract and the reviewed shop drawings

2. Confirmation that each of the control system components is working properly so the programmer can configure the control system software as required. This includes testing of all:

   a) Discrete input modules by electrically turning the input on and verifying the status through the programming device.

   b) Discrete output modules by electrically forcing the output on through the programming device and monitoring the electrical status of the output.

   c) Analogue input modules using a signal generator and monitoring the analogue signal through the programming device over its entire range.

   d) All analogue output modules using programmed values through the programming device and monitoring the electrical signal over the entire range.

   e) Communication between control system components is installed and is functional.

   f) All the software programming modules are installed correctly and are functional.

3. Software Modules Testing:

   a) Auto-programming to verify the remote control capabilities of the operator interfaces and the communication between PLCs.

b) Setting auto program parameters and issuing commands via operator interfaces.

c) Monitoring outputs via operator interfaces.

d) Using the graphic display editor to create, store and modify graphic display pages, where such a display or its programming is included in the scope.

e) Alarm display and special feature tests.

f) Demonstration of alarm displays and annunciations

J. Perform the SATs on site, at the plant. These SATs include all hardware and software supplied under this contract. A successful completion will be one of the criteria required for the substantial completion of the works. These include:

1. Demonstrate and confirm that all the field instruments, control panels and communication links have been supplied, installed and connected as per reviewed shop drawings and are operating as required by the Contract.

2. The testing procedure shall include exercising all process control narrative requirements and of all graphic interface features and criteria of passing the test for each feature.

3. Demonstrate that all changes required by Engineer following FATs where addressed.

4. Demonstrate that a reviewed set of shop drawings was made available to the Engineer before the SATs.

5. During trial period provide all required test equipment such as meters, scopes, calibrators, communication equipment, printers, data loggers, computers etc. and competent technicians are available on site to assist in demonstrating the correctness of installation and functionality.

6. Reconfirm all testing completed in previous tests. Compliance with proper operation will be judged over a trial operation period. Any failure of the system shall constitute a new initiation of the SATs once deficiencies are corrected.

7. Responsibilities:

a) Be present and prepared as indicated above for the duration of the trial period, 24 hours/day.

b) Follow the agreed test procedure in testing the systems.

c) Keep a test log, based on reviewed test procedures in which indicate all tests, significant events and failures with times, durations and actions taken.

d) The Contractor shall be responsible for all extra time lost and/or spent on remedial works due to failures by your own forces.

3.04 Equipment Installation:

A. Provide all necessary labour, equipment, tools, anchor bolts etc. unless otherwise specified, for the complete installation of all equipment supplied under this Section and the loose panels and instruments supplied by package suppliers.

B. Install all equipment in a workmanlike manner and in accordance with the manufacturer's drawings, instructions and/or under the direction of his qualified technical representative.

C. Provide and install all lubricants necessary for initial operation of the equipment in accordance with the manufacturer's instructions.

D. Supply all equipment with factory applied finishes. Where required, perform on-site finishing according to manufacturer's specifications.

E. For factory applied finishes, repaint or refinish surfaces damaged during shipment, erection or construction work to an as-new condition. Make provisions to mask before, and clean equipment after, final site painting.

F. Expedite the ordering and delivery of all materials and equipment required. No claims shall be considered for delays or additional expenses resulting from failure to place orders in ample time.

G. Arrange for regular inspections and a final inspection with the local electrical authority.

3.05 Equipment Protection:

A. Take delivery, offload and store all equipment on site in accordance with the equipment manufacturer's recommendations. Be responsible for any storage charges and obtain from each manufacturer instructions on the correct storage procedures.

B. Remove temporarily existing devices which may be damaged during construction. Re-calibrate such devices after re-installing them back in place.

C. After installation and before operation, protect all equipment against weather, dust, dirt, dampness and any other damaging factor in a manner satisfactory to the Engineer and in accordance with the manufacturer's instructions.

3.06 Nameplates:

A. Provide nameplates for each piece of instrumentation, equipment or device.

B. Each device will be tagged with at least one nameplate, visible from its operation side.

C. Materials: lamicoid, for panel and wall mounted nameplates and stainless steel for nameplates attached to field instruments.

D. Nameplates shall be fastened with stainless steel hardware to the device or, if not possible, to a pipe or wall in its immediate vicinity.

E. The text shall be engraved.

F. Finalize nameplate lettering at the shop drawing review stage.

3.07 Supervision and Commissioning:

A. The SATs are part of the commissioning/start-up stage.

B. Allow for supervision and commissioning period for thoroughly checking the final installation and performance of each individual piece of equipment, to certify that the equipment is correctly installed, to check each loop control, to start up the equipment and verify the installed equipment accuracy and to test application software performance, and to instruct the BMC's staff on the operation, programming and maintenance of the system. The work shall also include site supervision of the installations where necessary, repairs and/or adjustments to the supplier's equipment and coordination of the field supervision by other suppliers within their areas of responsibility.

C. The start-up procedures require the cooperation and presence of the Engineer or his designated representative. Coordinate the work and completely commission the entire control and instrumentation system so that it is in perfect running order to the satisfaction of the Engineer.

D. Remain responsible for a complete and working system, in full conformance with these documents.

E. Equipment checks, calibration and operator training are to be performed

3.08 Documentation:

A. Provide complete certified documentation on each instrument programming, settings, calibration and verification, including any changes that may have been made during

start-up and commissioning.

B. Provide the necessary documentation and instructions for reprogramming and setting of all instruments.

C. Supply maintenance and calibration manuals for the control and instrumentation system equipment. On satisfactory completion and certification of operation as intended, provide As-Built Drawings and detailed wiring diagrams for equipment and field connections.

D. Supply As-Built cabling layouts indicating field cable runs.

E. For application software see Section 3.

3.09 Training and Support:

A. Provide, in addition to 3.07 above, the following minimum on-site training:

1. One session of 3 days (a total of 24 hours) in the use of the control system, to be performed before commissioning

2. One session of 2 days (a total of 16 hours) for software reprogramming, to be performed before commissioning.

3. One session of 1 day (a total of 8 hours) for training refresher, to be performed close to the end of guarantee period.

B. Provide engineering support during the guarantee period.

END OF SECTION 1

SECTION 2 - PROCESS NARRATIVE

PART 1 - GENERAL

1.01 Reference:

A. This Section is to be read in conjunction with Mechanical and Electrical specification, which include specifications on software development, PLC panels and vendor supplied equipment, each forming an integral part of the control system for the facility.

B. This Section to be read in conjunction with other sections of this document.

C. This Section to be read in conjunction with the Process & Instrumentation Diagrams.

1.02 Work Included:

A. Supply, installation, testing and commissioning of a control system, which provides the means of operating the Pumping stations as described within this Section, as well as within the specific equipment specifications contained within Mechanical and Electrical specification and as shown on the drawings.

B. Implementation of a fully automated control system based on the drawings, specification, datasheet in compliance with the P&IDs and vendor packages supplied by the Contractor.

1.03 Related Work by Other Divisions:

A. The following related work is covered elsewhere in the control documents:

1. Equipment Specification
2. Mechanical Specification
3. Electrical Specification

1.04 Alternatives:

A. Void

1.05 Submittals:

A. Submit shop drawings and product data sheet as specified in Section 1 and As-Built Drawings.

1.06 Codes and Standards:

A. The application standards as referred in Electrical Specification established by the Bureau of Indian Standards (BIS), ASTM, BS and IEC govern the materials and

workmanship employed in the manufacture of all items.

B. Where provisions of the pertinent codes and standards conflict with these Specifications and Drawings or with each other, comply with the more stringent provision.

C. Use the latest issue of standards.

1.07 Integration of Package Systems:

A. As shown in the drawings and as specified in this section, these systems are to be integrated into the SCADA system.

B. SCADA screen shall indicate following minimum real time status/ values:

a) Continuous Differential Level across Mechanical Bar Screens and alarm set points

b) Continuous Level (individual Level values from both LIT) of Wet Well compartments and alarm set points

c) Continuous Pressure of individual pump, common header and alarm set points

d) Individual pump/ motor bearing temperature instantaneous values and alarm conditions through temperature scanner

e) Individual motor winding temperature instantaneous values and alarm conditions through temperature scanner

f) RUN/ OFF/ TRIP/ AVAILABLE/ EMERGENCY STOP OPERATED status for all individual Pumps

g) START / STOP Command for all individual Pumps

h) OPEN / CLOSE Command for all individual Auto Valves

i) LOCAL / REMOTE selection feedback for all individual Pumps, isolation gates/ valves

j) AUTO / MANUAL selection from SCADA

k) Delivery Flow rate from flowmeter installed at locations mentioned in ‘Section 4, Part-2, General point No. H’.

l) Individual pump bearing X-Y axis and Motor bearing X-Y axis vibration instantaneous values and alarm conditions.

C. The Contractor is responsible for providing a fully integrated overall SCADA/HMI system which includes these package systems.

D. Provide control and monitoring of systems from the SCADA/HMI as per different level/ hierarchy.

E. The contractor shall provide min. 12" HMI integral to PLC panel. All the monitoring and operation functions shall be available on PLC panel mounted HMI.

1.08 Provision for Future Connection to SCADA System:

Make provision in the automation system (hardware and software) for future expansion and communications to facilitate monitoring of all necessary parameters of Ghatkopar IPS at WwTF SCADA (in future by OTHERS).

1.09 Purpose of this Document:

A. This document shall guide the Contractor to finalise the detail version of process control narrative.

1.10 Definitions:

A. Programmable Logic Controllers (PLCs) and Remote Processing Units (RPUs) are terms that may be used interchangeably to describe hardware that runs the process in accordance with the software and the feedback signals from the field instruments and and other devices.

B. Hand/Manual is a term that may be used interchangeably to describe human control as opposed to automated or machine control

C. Equipment failed – a failed signal received from a field device to the PLC when the item of equipment fails to perform as required.

D. Equipment available - equipment that is in automatic mode and not failed.

E. SCADA – Supervisory Control And Data Acquisition. Typically, SCADA workstation.

F. HMI - Human Machine Interface

1.11 Proposed Detailed Process Control Narrative:

A. The document shall be organized in chapters as specified below, one for each piece of equipment and sub-system so that all system inputs, outputs, operations, SCADA systems and alarm functions are clearly defined.

B. Each chapter shall describe all controls of the subject entity (PLC, SCADA, HMI and field).

C. Each chapter shall include:

1. A list of points (inputs, outputs, virtual) and indicate whether each point is:

a) SCADA/HMI monitored, “I”, and/or

b) A controlled point, “C”, and/or

c) An alarm point, “A”

2. A control description indicating interface and coordination with hardwired controls or external devices, set points for each of the following scenarios:

a) Manual control (PLC control failed)

b) HMI control (SCADA control failed) automatic control and monitoring of equipment from HMI without print application.

c) Remote or SCADA/HMI control (operation with PLC and SCADA/HMI running):

i) Auto control (PLC)

ii) SCADA/HMI control (CPU manual / CPU Auto)

iii) List of applicable SCADA/HMI screens

iv) Description of each SCADA/HMI screen including trending and alarms for the last year

v) Description of the recommended equipment operation.

D. A chapter on alarms describing alarms and alarm handling.

E. A list of abbreviations for terms not defined in point lists.

F. The Contractor will consult with the Engineer to develop details for their own version of a detailed process narrative.

G. All deviations from the control strategies, alarm handling and SCADA/HMI set up, as described herein shall be clearly marked in Contractor developed version of this document.

1.12 SCADA/HMI system:

A. As a minimum, the SCADA/HMI system shall provide the following controls and indications (C, I) for each item of equipment:

1.	RUN/ STOP COMMAND and STATUS	(C, I)
2.	OPEN/ CLOSE COMMAND and STATUS	(C, I)
3.	CONTROL MODE– AUTO/ MANUAL	(C, I)
4.	EQUIPMENT FAILURE	(I)

5. RUNTIME (I)

6. No. of STARTS and STOPS (I)

B. Additional Indication:

1. All other inputs, outputs as per this process narrative's requirement and all computed data

2. English language description of abbreviations, acronyms or codes.

C. SCADA/HMI control levels of authorizations:

1. The SCADA and HMI systems shall have the facility to provide a minimum of five levels of authorization as directed by Engineer's hierarchy.

2. Controls for operator level of authorization:

   a) Operation of each item of equipment from SCADA

   b) View each parameter of each item of equipment and field instruments described in process narrative

   c) Acknowledgement of alarms and resetting

   d) View graphical trend of all items of equipment and field instruments, described in the process narrative

3. Controls for higher level operator or engineer's authorization:

   a) All controls and displays provided for operator level of authorization

   b) All soft set-points for graphical trend, alarms and controls

   c) All process control timers

   d) All applicable PID loop control parameters (cycle time, actuation duration etc.)

   e) Printing of reports, graphs etc.

4. Control for administrative level:

   a) All controls provided for higher level operator or engineer's authorization

   b) The ability to change or modify the SCADA and HMI logic/programme using programming language

5. Printing of reports, graph etc. shall possible from the SCADA system only.

6. All control levels of authorization described herein are applicable for the

control room HMI system and the SCADA system unless otherwise specified

D. Message Priority:

1. Highest priority: the last unacknowledged alarm.
2. If no unacknowledged alarm is present, display last status change

E. Pumping station overview includes:

1. Wet well water level (each compartment)
2. Sewage discharge flowrate (individual pump)
3. Individual pump and Pumping station discharge pressure
4. Pump/ motor bearing and winding temperature
5. Pump/ motor bearing vibration
6. Alarm log

F. All controlled and monitored equipment shall be available to the operator on the SCADA/HMI system. This includes all field equipment and instruments required in process area.

G. The PLC shall be programmed in such way that any settings regarding the set points shall be possible from the operator interface system (SCADA or HMI) end without taking the PLC online with a PC or Laptop.

H. SCADA and HMI Screens

1. Mechanical Bar Screen:

   Status of Mechanical Bar screens which are in the STOP or Ready to Run position shall be displayed in GREEN and Mechanical Bar screens in the START/ RUN status shall be displayed in RED. The Trip position of Mechanical Bar screens shall be displayed in AMBER. Mechanical Bar screens which are out of service for maintenance, shall be shown in ORANGE clearly flashing that the ‘Bar Screen is out of service’.

2. Belt Conveyor:

   Status of Belt Conveyor which is in the STOP or Ready to Run position shall be displayed in GREEN and Belt Conveyor in the START/ RUN status shall be displayed in RED. The Trip position of Belt Conveyor shall be displayed in AMBER. Belt Conveyor which is out of service for maintenance, shall be shown in ORANGE clearly flashing that the ‘Belt Conveyor is out of service’.

3. Pump-Motor:

   Status of Pump-motor sets which are in the STOP or Ready to Run position shall be displayed in GREEN and Pump-motor sets in the START/ RUN status shall be displayed in RED. The Trip position of Pump-motor sets shall be displayed in AMBER, Pump-motor sets which are out of service for maintenance, shall be shown in ORANGE clearly flashing that the 'Pump is out of service'.

4. Electrically actuated Sluice Gates /Valves

   Status of Electrically actuated Sluice Gates /Valves which are in the Close or Ready to Open position shall be displayed in GREEN and Sluice Gates /Valves in the Open status shall be displayed in RED. The Trip position of Sluice Gates /Valves shall be displayed in AMBER.

5. All field mounted instruments including Radar level sensors and transmitters, Pressure transmitters and Flow meters shall continuously display real time readings on SCADA screen. Faulty instruments shall display in BLINKING RED.

6. Status of all equipment and hydraulic profiles displaying on SCADA screens shall be based on real time.

7. The first SCADA/HMI screen, which opens by default, shall show links to all other SCADA screens.

8. A second SCADA/HMI screen showing Pumping station layout plan with the locations of Mechanical bar screens, Belt Conveyor, submersible Pump-motor sets, actuators, all field instruments and their status.

9. A third SCADA/HMI screen showing the Pumping station in elevation and on which the location of submersible Pump-motor sets, actuators, all field instruments including hydraulic flow diagrams shall be shown.

10. A fourth SCADA/HMI screen showing real time parameters of multifunctional digital panel meters including voltage, current, active power, reactive power, apparent power, power factor and frequency, installed at the incomer of the MCC. Same screen also shows status of UPS required in Pumping station i.e. 230V UPS Input fail, overload, Battery discharge etc.

11. A fifth SCADA/HMI screen showing individual Pump motor sets with electrical parameters including voltage, current, power factor, power consumed, direction of run, number of starts/hour for last 12 hours, total running hours

and total standby hours under each respective Pump motor set.

12. A sixth SCADA/HMI screen showing all electrically actuated gates and valves with respective equipment parameters including Run/Stop, direction of run (closing/opening), status showing fully closed/fully open, intermediate position of gate/valve if stops due to any reason, voltage and current.

13. A seventh SCADA/HMI screen shall display status of flush bottom sluice gate at inlet of individual chamber of Wet well, with the help of limit switches provided by the manufacturer on sluice gate. A eighth SCADA/HMI screen shall display the following:

    a) Wet well level from Radar level sensor 1

    b) Wet well level from Radar level sensor 2

    c) Magnetic flow meters reading with totaliser

    d) Pressure transmitter reading,

15. A ninth SCADA/HMI screen shall display graphical trends showing level from wet well Radar level sensors with respect to real time.

16. An tenth SCADA/HMI screen shall display graphical trends showing the flow as measured by the magnetic flow meter with respect to real time.

17. A eleventh SCADA/HMI screen shall display graphical trends showing the pressure as measured by pressure transmitter with respect to real time.

18. Faults occurring in the automation system and field instruments shall display on SCADA/HMI screens with a pop-up window. At the same time, an audible alarm shall sound for the remote indication of a fault.

19. The time of an alarm acceptance, changes in any soft set-points of process or process control timers shall be clearly displayed with the login name of modifier.

20. One pop-up screen for each device which has more than two inputs or outputs.

21. All screens on the HMI and SCADA system shall be identical and equal in number.

1.13 Data storage in SCADA

A. ‘SCADA server with historian data storage’ shall have capacity of minimum 2TB to store following data as minimum, based on real time clock.

Sr. No.	Equipment	Parameter to be stored for 5 years	Interval of data storing
1.	Incomer of HV SWBD (VCB/SF6) (For Ghatkopar IPS)	On/Off/Trip status, Reason and Time of Tripping	As and when activity take place
2.	Energy meter (HV SWBD) (For Ghatkopar IPS)	Active power, Reactive power, Apparent power, Frequency, Power factor, Voltage	15 min.
3.	Incomer of LV MCC (ACB/ MCCB)	On/Off/Trip status, Reason and Time of Tripping	As and when activity take place
4.	Energy meter (LV MCC)	Active power, Reactive power, Apparent power, Frequency, Power factor, Voltage	15 min.
5.	Energy meter (HVAC)	Voltage, kWH, kVARH, Power factor, Frequency	30 min.
6.	Mechanical Bar Screen	Start/stop command, Run/Trip/Stop status, Manual/ Automatic switch position	As and when activity take place
7.	Belt Conveyor	Start/stop command, Run/Trip/Stop status, Manual/ Automatic switch position	As and when activity take place
8.	Main Pump motor set	Start/stop command, Run/Trip/Stop status, Running period, Total running hours, Reason of tripping (Starter internal fault/ Overload Trip) with time, Manual/ Automatic switch position	As and when activity take place
9.	Electrically operated Sluice Gates /Valves	Open/Close command, Run/Trip/Stop status, Manual/ Automatic switch position	As and when activity take place
10	Automatic power factor controller	On/Off status	As and when activity take place

Sr. No.	Equipment	Parameter to be stored for 5 years	Interval of data storing
	and Capacitor bank		
11	Electric Actuators	Open/Close/Stop command, Close/ Open/ Trip status	As and when activity take place
12	Uninterrupted power supply	UPS fail, overload, battery discharge, Main ON, Battery charging, Battery power ON status	As and when activity take place
13	Magmeter	Instantaneous Flow measurement	15 min.
		Totalized flow in MLD	24 hours
		Healthy/ Unhealthy (Faulty) status i.e. Fault in magmeter, Communication error	As and when activity take place
14	Pressure Transmitter	Pressure measurement	15 min.
		Healthy/ Unhealthy (Faulty) status i.e. Fault in Pressure transmitter, Communication error	As and when activity take place
15	Wet well Radar level detector 1	Wet well level measurement 1	15 min.
		Healthy/ Unhealthy (Faulty) status i.e. Fault in Radar level detector 1, Communication error	As and when activity take place
16	Individual pump/ motor bearing temperature	Individual pump/ motor bearing temperature	15 min.
		Healthy/ Unhealthy (Faulty) status	As and when
		i.e. Fault in temperature measurement, Communication error	activity take place
17	Individual motor winding temperature	Individual motor winding temperature	15 min.

Sr. No.	Equipment	Parameter to be stored for 5 years	Interval of data storing
		Healthy/ Unhealthy (Faulty) status i.e. Fault in temperature measurement, Communication error	As and when activity take place
18	Wet well Radar level detector 2	Wet well level measurement 2	15 min.
		Healthy/ Unhealthy (Faulty) status i.e. Fault in Radar level detector 2, Communication error	As and when activity take place
19	Limit switch of Sluice gates	Gate open/ close status	As and when activity take place
20	Fault acceptance from SCADA, change in soft set point or process control timer etc.	Occurrence of any given activity shall be logged into SCADA system with login name and time	As and when activity take place

1. Each fault on the system shall logged to SCADA system Contractor shall arrange for additional process data storage requirement (i.e. Portable Hard Disk), if any as suggested by an engineer.

1.14 General Operational Overview:

A. This is applicable to all Pumping stations, except that the number of items of equipment required to be provided and installed may vary as required. The process logic will be the same.

B. The major components of Pumping stations to be considered are identified in the following control narratives which are intended to capture the control methodology for a fully automated Pumping station.

C. Without foregoing any of the information contained within this document, the purpose of the control system is to provide the BMC with a fully automated facility capable of being controlled manually in the event of a SCADA/HMI system failure.

1.15 Process Area:

A. Inlet Chamber

a) One Electrically Operated sluice gate is installed at each of the entry to inlet

chamber to isolate the Pumping station. LOCAL/ REMOTE selector switch shall be located at MCC for remote starter or at actuator for integral starter.

b) LOCAL – When selector switch is in LOCAL mode, the actuator shall not operate through the PLC. The gate shall operate only from push buttons installed on the actuator or local pushbutton station. This will include OPEN, CLOSE pushbuttons for local operation. In this mode, opening of sluice gate will be manual from the push buttons.

c) REMOTE - When the sluice gate is placed in REMOTE mode, the actuator shall not operate through local push buttons. In remote mode the actuator shall operate from PLC. A High High alarm shall be generated in the system when the water level in inlet Chamber reaches High High Water level. The open/close position of the inlet sluice gate shall be indicated on the SCADA/HMI system.

B. Pump Control:

1. The Pumping stations shall generally be equipped with Variable speed Pumps. Pumps shall be operated based on the wet well water levels. The sewage Pumping system consists of the following:

Commented [SNC2]: Word "Fixed" replaced with "Variable"

a) Duty and standby sewage Pumps;

b) Soft starter/ conventional MCC for each sewage Pump

c) Two Radar level transducers and transmitters for each wet well water level measurement

d) Pressure Transmitter for individual and the rising main pressure measurement

e) Magnetic Flow meters at locations mentioned in 'Section 4, Part-2, General, point No. H'

f) Individual pump/ motor bearing temperature measurement and motor winding temperature measurement through temperature scanner

g) PLC and control logic software

h) Supervisory Control and Data Acquisition system

i) Human Machine Interface system

j) Individual pump bearings X-Y axis and motor bearings X-Y axis vibration instantaneous values and alarm conditions

C. Rising main and Bypass line:

1. Pressure Transmitter:

a) On individual pump and common delivery main, provide Pressure Transmitter with proper diaphragm and suitable valve arrangement for isolation. This shall measure the pressure at individual pump discharge and in the delivery main (to be installed inside valve chamber) to transmit to the SCADA/HMI system. In case of a failure of the PLC, Field mounted Pressure Transmitter shall continue to indicate the readings without fail or any disturbance.

2. Magnetic Flow Meter:

a) A magnetic flow meter of suitable diameter shall be provided at locations mentioned in 'Section 4, Part-2, General point No. H' to measure the pumping station total flow and transmit the data to the SCADA/HMI system. In the case of a failure of the PLC, the Field mounted flow meters and totalizers shall continue to indicate the readings without any disturbance.

3. Electric Actuators:

a) The inlet gates shall be provided with electrical actuator to isolate the Pumping station, when closed.

b) Individual delivery main valve actuators shall be fixed to the isolation valves before the magnetic flowmeter. Valve actuators shall be in the closed position when the magnetic flowmeter has to be isolated.

c) Actuator LOCAL/ REMOTE selector switch shall be located at MCC for remote starter or at actuator for integral starter.

LOCAL mode – When selector switch is in LOCAL mode, the actuator shall not operate through the PLC. The actuator shall operate only from push buttons installed on the actuator or local pushbutton station. This will include OPEN, CLOSE pushbuttons for local operation. In this mode, opening of valve will be manual from the push buttons.

REMOTE mode - When selector switch is in REMOTE mode, the actuator shall not operate through local push buttons. In remote mode the actuator shall operate from PLC. The open/close position of the valve shall be indicated on the SCADA/HMI system.

d) Failure of PLCs shall not affect the manual operation of any actuators.

1.16 Operation of Sewage Pumping Stations in Auto mode:

A. When the PLC receives the Pump START command the system will check all possible pre-requisites from sensors, equipment etc. and the Pump set shall start only if all conditions are satisfied.

B. Automatic Pump operation using water level transducers and transmitters.

a) Auto Pump operation shall be effective when,

i) At least one of the sewage Pumps is available.

ii) No alarms are indicated for the available sewage Pumps

iii) The PLC is functioning properly.

b) The PLC shall monitor the signals from the level transmitters in the wet wells and send start/stop instructions to the soft starter of the duty sewage Pumps in accordance with the set points mentioned at the end of this document.

c) If any transmitter fails completely, the SCADA/HMI system and the annunciator shall give an alarm, and allow the manual transfer the selector switch to another level transmitter. If both level transmitters fail or are out of range, the PLC shall ignore all level transmitter data and give the signal so that operator can put the system into manual mode.

d) If the duty-Pump stops running due to fault such as a tripped breaker, Pump seal failure (for submersible pump) or pump/ motor bearing or motor winding high temperature alarm/ tripping condition, the PLC shall automatically switch to next duty Pump. If all the duty Pumps are running and any one Pump fails, the PLC shall switch to the standby Pump.

e) Operations of the Pumps shall also depend on the position of the knife gate valves located on delivery main. The Pumps shall be able to start only when any one of the following condition is satisfied.

i) The delivery main valve and isolation valve both are in the OPEN state.

f) Pump alternation shall occur:

i) Upon operator selection (manual mode)

ii) For each Pump startup to provide rotational operation (automatic mode)

g) Pump Availability:

i) A Pump shall be available for the automatic sequence, if it is in MCC Remote mode and is not failed. The Pumps shall then be assigned lead, lag and standby duties. If the lead Pump is unavailable, the lag 1 Pump shall be used instead.

1.17 Manual mode of operation:

A. This mode of operation shall be adopted when the Auto-Manual selector switch is in manual mode.

B. Pumps shall be run in manual mode only when,

a) The PLC fails to operate,

b) A trial run is required on a Pump set during maintenance

C. The operator shall manually start and stop the Pumps according to the levels measured by the wet well Radar level sensors

D. In manual mode, Pump operation logic shall be designed in such a way that only one Pump can be started at a time and there should be a time delay of one minute between the starting of two consecutive Pumps.

E. Operational logic shall be design in such a way that operator can start the Pumps in the band of Low Low and High High level only.

1.18 Safety Provision:

A. Level Transmitters:

a) The Level transmitters provide safety backup for the Pumps, in the MANUAL and AUTO modes.

b) If the water level continues to rise and remain at the High High Water level for one minute, with or without the duty Pumps running, the Level transmitter derived High High level set point shall give the signal to close the inlet sluice gate.

c) If the water level falls below the Low Low level, the Level transmitter derived Low Low level shall stop all sewage Pumps through a connection to the MCC/ switchgear.

B. Alarm and its Conditions:

a) The entire alarm system shall be set to avoid nuisance alarms which may otherwise occur due to process, maintenance or power transients.

b) Whether the system is in AUTO or MANUAL mode, all equipment and instrument alarms shall be displayed on an annunciator with an audible alarm.

c) In the case of any fault, the respective annunciator light shall start blinking with an audible alarm

d) The audible alarm will run for 30 seconds every five minutes until it is acknowledged by the panel acknowledge push button.

e) The alarm lights on the annunciator will flash until the respective fault is cleared.

f) Equipment failure type of alarms shall be reset if the alarm situation is no longer present

g) The system will log the alarms for a minimum of two years. The event description and the time of the fault shall be retrievable, in reverse chronological order and shall be exportable to a portable computer.

h) All alarms shall designated as critical alarms require 24/7 monitoring and response. If the activation of an alarm is not critical and does not need an immediate response it is categorized as a non-critical alarm.

i) Critical Alarms

i) Main Pump failure
ii) Level sensors or transmitters fail
iii) The difference between the level indicated by two wet well Radar level sensors is more than 150 mm for two minutes.
iv) The magnetic flow meter fails
v) The wet well water reaches low low level
vi) The wet well water reaches high high level
vii) PLC failure
viii) Pump/ motor bearing temperature high
ix) Motor winding temperature high
x) Pump pressure low/ high
xi) Pump-motor moisture sensor/ leakage sensor activates
xii) Inlet sluice gate fails to close when wet well reaches high high level
xiii) Inlet sluice gate fails to open when wet well water reaches low low level
xiv) Pump bearings and motor bearings X-Y axis vibration high

j) Non-Critical Alarms

i) Pressure transmitter fails

k) The number of trips of the Pumps with the time of failure shall be displayed on the SCADA/HMI system. The reason for the trips shall also displayed.

l) The graphical trend of the Pump-motor status with real time monitoring shall be provided showing the numbers and time of trips or any faults.

m) The real time graphical trend of actuators shall be provided for observing the times of starts and stops of the actuators with their closing and opening state and the times of trips.

n) Starts per hours of particular Pump-motor sets shall be provided to monitor and prevent excessive numbers of starts.

C. Power Failure Scenario:

a) In the event of an electrical power failure, the Pumps will stop and the operator shall shift the system from Auto to Manual mode through the Auto-Manual selector switch, mounted on the instrumentation control panel.

b) When the electrical power supply resumes, the operator shall start the Pumps as required by observing the levels from the Radar level sensors. At the low low level, all Pumps shall stop due to the interlock. After all Pumps have stopped, the operator shall switch the system from Manual to Auto mode.

c) After a power failure and in the event the operator fails to shift the system to Manual mode, all Pumps will be start if the level has reaches the high level when the power resumes. Timers shall be provided to start any two consecutive Pumps with time interval of one minute.

d) A UPS for emergency power shall be provided for the PLC-SCADA/HMI system and CCTV system for 120 minutes duration.

D. PLC Failure Scenario:

a) In the event of a PLC failure, an alarm shall be generated and the operator shall transfer the system from Automatic to Manual and shall operate the Pumps manually according to the levels shown in the wet well. All Pumps shall be automatically stopped at the low low level by the Level transmitter auxiliary contacts interlock.

END OF SECTION 2

SECTION 3 – AUTOMATION SYSTEM

PART 1 - GENERAL

1.01 Reference:

1. Section 1 – Control and Instrumentation applies to and governs the work of this Section.

1.02 Work Included:

1. Supply, installation, testing and commissioning of the automation system.
2. The Drawings and Specifications set the acceptable standard. Ensure that the installed equipment is trouble-free and meets the performance requirements.

1.03 Related Work by Other Divisions:

1. The following related work is covered elsewhere in the contract documents:
   Electrical Specifications

1.04 Alternatives:

1. Not applicable for this section.

1.05 Submittals:

1. Shop drawings shall be submitted as specified in Section 1 and As-Built Drawings.

1.06 Codes and Standards:

1. The applicable standards as referred in Section 1 established by the Bureau of Indian Standards (BIS), ASTM, BS and IEC govern the materials and workmanship employed in the manufacture of all items.
2. Where provisions of the pertinent codes and standards conflict with these Specifications and Drawings or with each other, comply with the more stringent provision.
3. Use the latest issue of Standards.

PART 2 - PRODUCTS

2.01 Control Panel (CP):

A. Enclosure / Panel Details:

   1. Instrument Control Panels shall be free-standing, floor-mounted cabinets of the cubicle, console or desk pattern.

2. The height of the cubicles, with or without desk sections, shall not be greater than 2250 mm overall. In front of the panels, instruments and controls shall be mounted so that the height of their centres above the floor shall be between 900mm and 1800mm. Control switches and push buttons shall be positioned below or adjacent to any associated reading instrument.

3. PLC based control panels and SCADA hardware shall be installed in air conditioned (a/c) room/ glass partition. The wall mounted a/c unit having necessary tonnage capacity shall be provided to maintain PLC/ SCADA OEM recommended temperature desired for smooth, seamless operation and working of the automation system.

B. Panel design and construction:

1. The clearance between the extremities of apparatus mounted on the internal walls shall allow safe and convenient access to all terminals and to parts requiring maintenance. In the case of footways between such apparatus the clearance shall not be less than 800 mm.

2. Indoor panels shall have a minimum protection rating of IP51. Outdoor panels shall have an IP67 rating. CONTROL PANEL shall be prefabricated, having modular construction and shall comprise rigid welded structural frames enclosed completely of specially selected smooth finished, cold rolled sheet steel of minimum 2 mm thickness, internal mounting plates 3 mm and the gland plate shall be 3 mm thick. The panel shall be powder coated with a minimum finished thickness of 85 microns.

3. Sufficient reinforcement shall be provided in order to provide resistance to vibrations and provide sufficient rigidity during transportation and after installation.

4. Each panel shall be mounted on steel foundation channels and shall be provided with undrilled gland plates fitted at the floor level. Removable side covers to the gland plates shall be incorporated or another arrangement may be used that gives adequate access to the underside of the gland plates and ensures a vermin proof construction.

5. Panels shall be supplied with lockable hinged access doors. Doors shall be rigid and of folded construction and provided with close fitting flexible seals to prevent ingress of dust and vermin. Hinges shall be of the lift-off pattern and one hinge shall engage before the other for ease of fitting. Wherever necessary, removable access covers secured by quick release fasteners shall

be provided to ensure ease of maintenance to all installed apparatus.

6. No equipment other than front-of-panel items shall be mounted on internal panel surfaces and adequate provision shall be included for mounting plates and brackets which shall, if necessary, be hinged or otherwise arranged to give quick and easy access to equipment, securing screws, terminals and wiring. The design of panels shall ensure adequate ventilation and air circulation without permitting the entry of vermin and dust.

7. Temporary closures for panel openings shall be provided to prevent ingress of dust and vermin during transit and installation. The panels shall be further protected against damage prior to takeover. Provision shall be made for the safe and easy handling during transit and at site.

8. Lifting eyes, if used, shall be removable and panel tops shall be reinforced where necessary.

9. All panel construction details and arrangements shall be approved by the Engineer before manufacture. The manufacture of the panels shall be subject to inspection by the Engineer.

C. Nuts, bolts, studs and washers

1. All hardware shall be corrosion resistant. All joints and connections of the panel members shall be made by zinc passivated cadmium plated high quality steel bolts, nuts and washers.

D. Panel Lighting

1. Each panel shall be adequately illuminated internally, evenly and free from dazzle, by a fluorescent lighting fixture controlled from totally enclosed door operated switches. The lighting circuit shall be independently fused and designed to allow the lamps to be replaced safely.

E. Panel Heating

1. Each cubicle shall be fitted with one or more thermostatically controlled tubular heaters to prevent condensation and assist ventilation. The rating shall not exceed 60 watts per cubic foot and the surface temperature of any part that may be contacted accidentally shall not exceed 65oC. The heaters shall be situated so that no deterioration can be caused to any of the apparatus or wiring in the cubicle. The heating circuit shall be independently fused and controlled by a suitably labelled rotary pattern enclosed switch mounted in an accessible position within the cubicle.

F. Panel Termination Blocks/ Internal Wiring

1. Terminal blocks shall be of polyamide

2. Provision shall be made to terminate all incoming and outgoing wires at terminal boards mounted vertically, where possible, and not nearer than 230 mm to the floor or less than 230 mm from an incoming cable gland.

3. Convenient access to wires and terminals shall be provided. Ferrule shall be placed such that numbers can be read without difficulty. Terminal blocks having particular ac/dc voltage rating shall be segregated from other cable terminal blocks having different ac/dc voltage ratings.

4. Terminal blocks shall completely labelled to show the appropriate AC or DC working voltage. The space between two rows of terminal blocks shall not be less than 100 mm.

5. All connections shall be made on the front of terminal boards and no live metal shall be exposed at the back. Terminal boards and blocks shall clamp the wire securely and without damage between two plates by means of a captive screw. Pinch screw type terminal type blocks shall not be accepted

6. Connectors on terminal blocks shall have separate fixings for incoming and outgoing wires. It shall be possible to connect two wires on the same side of each terminal block, but not more than two shall be so connected. At least 25 per cent spare terminals shall be provided. Terminal blocks shall be numbered consecutively in a logical manner to facilitate identification and the location of terminals.

7. The terminal numbers, voltage grouping and terminal board layout shall correspond precisely with wiring diagrams so that quick and accurate identification of wiring can be made. All terminal boards shall be sectionalized where possible to give access to groups of terminals without uncovering all boards at the same time. Terminals which may be live when the equipment is isolated from the mains supply shall be suitably labelled to reduce the risk of accidental contact.

G. Panels – Composite:

1. In situations where space limitations preclude the use of separate instrumentation, control and automation (ICA) and switchgear panels ICA equipment may be combined within a single enclosure subject to the following conditions:

a) The observance of all other clauses herein relating to enclosures, mounting boards and minor panels.

b) The written assurance of each supplier of ICA equipment that the proximity of the switchgear will have no detrimental effect on the life or performance of any ICA component.

c) The total segregation of ICA equipment and switchgear including the glands and termination facilities.

d) The use of the full height of the panel for any ICA equipment compartment.

H. Panel Internal Wiring:

1. Panel circuits shall be segregated into the following categories:

a) Group 1: Power control and very-high-level signal wiring (above 50V):

i) AC power supplies;

ii) DC power supplies;

iii) AC current signals above 50mA (such as CT circuits);

iv) AC voltage and control signals above 50V (such as PT circuits).

b) Group 2: High-level signal wiring (6V to 50Vdc):

i) Circuits to Alarm Annunciations and other solid-state devices

ii) Digital signals;

iii) Emergency shut-down and tripping circuits;

iv) On/off control circuits;

v) Intrinsically safe circuits;

c) Group 3: Low-level signal wiring (5V dc and below):

i) Signals from all field instruments

2. For Group 3 wiring, internal connections to the instruments shall be made by one of the following methods:

a) The twisted, screened conductors of the external cable shall be led direct to their appropriate instruments via ducting systems installed for this purpose during construction of the panel;

b) The conductors of the external cables shall be terminated on terminals

segregated from all other categories and the connections to the appropriate instruments shall be made using twisted pairs with individual screening installed for this purpose during construction of the panel.

3. Internal wiring for all circuits in Group 2 except those sharing a common connection shall be multi-stranded, twisted pair, minimum 0.75mm² copper conductors with PVC-insulated cable of adequate grade and rating.

4. Wiring for circuits in other Groups or sharing a common connection shall be run in stranded, 1.0mm² minimum copper conductors with 250V grade, PVC-insulated cable of adequate grade and rating.

5. Wiring sheath colours shall be black for ac circuits, grey for dc and blue for Group 2 circuits. Circuits supplied at 240V and 110V dc shall be physically segregated from each other and from other circuits. Access to wiring and components of circuits having voltages exceeding 240V shall not be possible unless and until the circuit has been isolated.

6. Separate ducts, trunking, cable looms, tray work and the like shall be provided within the panel for each category with at least 150mm between parallel paths of Group 1 and those of any other Group. Intrinsically-safe circuits and their terminals shall be segregated from other circuits and terminals.

7. All wiring shall be neatly and securely fixed by insulated cleats, bunched and secured by approved plastic strapping or run in approved insulated wiring trunking or non-corrodible flexible tubing. Not more than 75% of the capacity of trunking, ducts, looming or tubing shall be used. Insulated earth wiring shall be arranged so that access to any equipment or connection point or the removal of any item of equipment is unimpeded.

8. Wiring for future equipment shall be secured and terminated on terminal blocks. Lacing for wiring looms shall be of rot-proof cord or plastic strips. Inter-section wiring in multi-section cabinets shall be via a terminal block in each section.

I. Panel Wiring Identification and Termination:

1. Identification ferrules shall be fitted at both ends of each wire. The numbers or letters used shall correspond with the appropriate wiring diagram. The ferrules shall be of plastic insulating material with permanent black characters

on a colour coded background for numbers and on a white background for letters, and shall be unaffected by oil or water. They shall be arranged so that they can be read logically from left to right when viewed normally.

2. The system of wire identification shall be such that wires in the same circuit on opposite sides of a terminal shall have the same reference and this system shall be continued through all external cabling.

3. Terminal ferrules (spade, tongue, crimped connections) shall be provided on each conductor.

J. Panel Earthing

1. A copper earth bus bar of not less than 25 mm x 3 mm section shall run the full length of each panel Section 1nd be bonded electrically to the main frame. It shall be provided with suitable terminals of not less than 8 mm diameter for connection or the metal cladding or armouring of all incoming and outgoing cable and to the site earthing system. Suitable terminals shall also be provided for connecting the earth wiring of instrument and equipment cases.

2. In multi-section panels, each earth bar shall be electrically bonded to the corresponding bars in the adjacent section.

3. The Contractor shall provide separate earth pits for instrumentation. Electric earth pits shall not be used for earthing of instrumentation equipment. All signal cable screens (analogue and digital) shall be terminated onto the instrument earth bar which shall be separately provided inside Panel. Signal cable screens shall be earthed at the CONTROL PANEL end only. Screens at the field end shall be tied back and insulated.

K. Miniature Circuit Breakers (MCBs) and Panel Isolation

1. CONTROL PANEL panels shall be provided with the necessary arrangement for receiving, distributing, isolating and protecting of DC and AC supplies for various controls, signalling, lighting and space heater circuits. The incoming and sub-circuits shall be separately provided with two pole miniature circuit breakers (MCBs). Potential circuits for relaying and metering also shall be protected by MCBs.

2. Adequate fuse protection of circuits and sub-circuits shall be provided where MCB protection is not suitable and shall be arranged so that any fuse causes minimum distribution of plant and cannot result in any unsafe operating condition. MCBs, clearly labelled, shall be provided for all incoming power

supplies. They shall be of the quick make and break type with spring-loaded contacts that close fully without requiring full operation of the handle, which shall be so interlock with the cover that it cannot be operated when the cover is open. The 'ON' & 'OFF' position of each switch shall be unambiguously indicated. Wiring from each isolator to its fuse board shall be capable of carrying the isolator rated current safely unless a fused isolator is employed. Every indicating or recording instrument requiring a power supply shall be individually wired and fused so that in the event of a failure in one circuit the remainder are unaffected. For this purpose, socket outlets with fused plugs may be used if considered more convenient or economical.

L. Push buttons and Switches

1. Push buttons for operational circuits shall be provided with a shroud, guard or other suitable means to prevent inadvertent operation. They shall be in accordance with the high standard generally required by the specification as a whole and by the equipment with which they are associated

2. Illuminated push buttons, where used, shall be of a design that allows easy replacement of the lamps from the front panel. If legends are engraved on the push buttons they shall be clear and concise and shall be approved by the Engineer before manufacture.

3. Switches shall be in accordance with the high standard generally required by the Specification as a whole and by the equipment with which they are associated.

M. Indicating Lamps

1. Indicating lamps shall be of a type that gives adequate illumination in brightly-lit surroundings. They shall permit convenient replacement of lamp bulbs from the front of the panel and shall operate at a sufficiently low voltage to ensure safety during replacement without the need to isolate the electrical supply. The lamps shall be cluster LED type. Each lamp shall have either a descriptive label affixed beneath the light fitting or an engraving on the screen or the fitting.

2. All wording on the labels shall be approved by the Engineer before the manufacture of the labels

N. Panel Ventilation:

1. Each panel shall be provided with ventilation fans as required to ensure that

equipment within the panel is maintained within manufacturer's recommendations, with due regard to the environment in which the panel will be mounted. Fans shall be controlled by a suitably-labelled enclosed switch mounted internally in an accessible position.

2. Fans shall be mounted with their axes horizontal and shall be arranged to draw clean air into the panel. Air entries shall have filters which can be renewed from outside the panel and shall be designed to prevent the entry of rain, spray, injurious fluids, sand or dust.

O. Panel Labels:

1. All control gear shall be fully labelled for identifying the equipment designation/function, all external and internal components, all rating data, detailed equipment operating data and for danger and hazard warning.

2. Labels shall be provided for every panel to describe the duty or otherwise identify the panel and it's sections and every instrument, component and item of equipment mounted internally and externally. Wording shall be clear, concise and unambiguous and shall be subject to review by the Engineer before manufacture. Each label shall be permanently secured to the surface near the item to which it refers. Externally-fitted labels shall be of perspex or other approved transparent plastic, with letters and numbers rear-engraved and filled with black.

3. The rear surface of each Perspex label shall be finished with a coat of paint of the same colour as the panel external finish. Instrument duty labels fitted externally shall be below the item to which they refer. Embossed tape or similar adhesive labels shall not be accepted.

4. Laminated materials or rear-engraved and filled plastic shall be used for internally fitted labels, which shall be white with engraved black letters.

5. Labels conforming to the requirements of the preceding paragraphs or other approved means shall be provided:

   a) To describe or identify circuits or circuit components;

   b) To identify dc polarity;

   c) To warn or remind about dangerous or potentially-dangerous circumstances; and

6. Unless otherwise specified, all engraving shall be in plain block letters, 4mm

high and panel main nameplate letter should be 15mm high

7. The minimum practicable number of different sizes shall be used.

8. Instrumentation panels shall carry the nameplate of the system integrator with the original equipment manufacturer's name.

9. Provide unique logical identification to all CONTROL PANELs and record these in the Operation and Maintenance Manuals.

P. Panel finish:

1. For CONTROL PANELs, desks and cubicles, a hard, smooth, durable finish, free of blemishes, shall be provided. Before painting, all external welds and any rough areas shall be smoothened and all surfaces shall be thoroughly cleaned and free from scale, contaminates, corrosion or grease.

2. The panel shall be treated with a passivating agent.

3. All internal surfaces shall have a minimum of three coats of paint of which the first shall be an approved anti-rusting priming coat and the final coat shall be opaque gloss white enamel. All external surfaces shall have not less than five coats of paint of which the first shall be an approved etch-priming coat and the second and third suitable undercoats, all of which shall be rubbed smooth when dry before application of the next coat. The undercoats shall be easily distinguished in shade or colour from the priming and finishing coats. The two final coats shall be of stove enamel paint, gloss or semi-matt finish, to a colour and finish to the approval of the Engineer.

4. The panel internal surfaces shall be white and the external colour shall be RAL7032.

5. The overall dry film thickness shall be between 85 and 120 microns.

6. Nuts, bolts, washers and other fixing devices which may have to be removed for transit or maintenance purposes shall be galvanized or otherwise finished to an approved standard.

2.02 Control Panel Devices:

A. General:

1. This Section is intended to provide functional descriptions of the devices required and to serve as a guide to the supplier in designing the panel. The

Contractor is required to submit supplier designed complete control wiring, shop and loop drawings.

2. The following shall be adopted when arranging the instruments on the panel:

   a) Sufficient space shall be provided for easy maintenance,

   b) A logical and tidy layout,

   c) All safety requirements,

   d) Indications to be readily legible,

   e) Logical grouping of push buttons etc.

3. Nameplates shall be integral with the instruments and switches.

4. All instrument terminals shall be fast clip-on or plug type connectors. Screws shall not be used for internal terminations.

5. Provide all required current isolators, signal conditioners, interposing relays and any other instruments and appurtenances which shall be required, in order for the entire panel to operate as intended.

6. All door mounted equipment shall be installed flush mounted and properly sealed.

B. Control Relays:

1. Relays shall be from an approved manufacturer. All relays shall have a minimum of three potential free contacts.

C. Status Lights:

1. Status lights shall be push to test, with appropriate colour lens and legends.

2. Bright, long life (minimum 120,000 hrs) LED clustered panel indicators shall be used for CONTROL PANELs, of the appropriate colour and from an approved manufacturer.

D. Alarm:

1. Alarm annunciation shall be provided by generating audiovisual alarms for each abnormal condition. Alarms shall be made available on SCADA & HMI both, directly through DO.

2. Alarm Accept and Alarm Reset push buttons shall be provided on SCADA/HMI screens.

E. Alarm System Operation:

1. Alarm Annunciation and audible alarms shall operate as follows:

    a) On pressing the Alarm Accept push button, the audible alarm shall be silenced and the flashing shall become steady.

    b) The alarm indication shall remain active whether or not the alarm condition has returned to normal until the Alarm Reset push button has been operated, whereupon the light shall be deactivated, if the fault condition no longer exists.

    c) The alarm system shall respond to any new condition arises, even while an existing condition is being indicated.

F. Hand Selector Switches:

1. Hand selector switch contact blocks shall be the heavy duty silver to silver butting type or, on low voltage or multi-amps circuits, have gold plated contacts. The Contractor shall provide the number and arrangement of contacts and their function in accordance to requirements. The schematic control diagrams shall be submitted to the Engineer for approval.

2. Selector switches and field and MCC control mode selectors shall have make-before-break contacts. The auto-off-manual selector switch and On-Off- Test selector switch shall be provided in all CONTROL PANELs with a suitable current rating.

G. Surge Protection:

1. Features:

    a) Surge protection devices (SPDs) shall be suitable for withstanding the surge arising from high energy static discharges and lightning strikes and protect the instruments to which it is connected. SPDs shall be passive and shall require negligible power for operation.

    b) SPDs shall be provided to protect devices transmitting and receiving analogue and digital signals from outdoor field devices.

    c) The surge protection devices shall comply with IEC 61643.

2. Provide surge protection devices for all field devices, data communication lines and buried signal cabling.

H. DC Power Supply – Switched Mode Power Supply:

1. This shall be provided in the PLC panels for the dc power supply to PLCs.

2. Features:

a) Power supplies shall be rail mounted and suitable for the application.

b) Input power to be 200 - 240 V ac, 50 Hz.

c) The output voltage shall be adjustable 22-30 V dc.

d) Two power-supply units (1 operational + 1 standby) shall be provided per panel in parallel mode, each having the capacity to supply the total load. The power supply unit shall have diode protection.

I. Power Failure Relay:

1. Power failure relays shall be provided, one per UPS. The relays shall be wired into the 230 V ac Control Panel supply and indicate when the 230 V ac supply has failed.

2. The relays shall be connected to the PLCs, with contact open on power failure.

J. Drawing Pocket:

1. Drawing pockets of suitable size shall be provided at rear of the panel doors for keeping As-Built Drawings.

K. Instrument Toolkit:

1. The purpose of the instrument toolkit is to equip the maintenance department personnel for maintenance practices to cut down the failure rates of instruments and reduce the malfunctioning of field devices.

2. The toolkit shall contain the following tools:

a) Screw driver set (flat) – 6 x 125 mm, 5 x 75 mm, 2.4 x 75 mm – 1 set

b) Screw driver set (cross) – 6 x 125 mm, 5 x 75 mm, 2.4 x 75 mm – 1 set

c) 30 W soldering Iron with stand, de-soldering pump, solder wire and flux – 1 set

d) Needle file set – 2 sets

e) Nut driver – 3/16”, 1/4” – 1 set

f) Snap-off knife – 1 number

g) Heavy duty universal pliers – 5¼” - 1 number

h) Heavy duty long nose pliers – 5¼" – 1 number

i) Heavy duty universal cutter – 1 number

j) Self adjusting wire stripper – 8½" – 1 number

k) Adjustable wrench – 6" – 1 number

l) Electrical screw driver with neon indicator – 5 x 90 mm – 2 number

m) Crimping tool for connectors – 1 number

n) Heavy duty moulded tool box with lock and three keys for accommodating the above tools and a digital multimeter. The tools shall be firmly held in an elastic holder inside the toolkit.

2.03 Data Processing System:

A. Definitions:

1. Under this Contract, the data processing systems shall be responsible for all microprocessor based automatic controls. They shall generally consist of PLCs connected together on a data communication network.

2. Servers are commercial grade PC based systems with the latest configuration responsible for the control of the SCADA applications and database.

3. Switches and routers are used as electronic junctions or address handling boxes which keeps all systems and sub systems linked to each other.

2.04 Minimum Specification for PLCs:

A. Automation System:

1. It shall be possible to adapt automation systems to their respective requirements. The systems shall comprise space-saving designs with flexible networking, connections to control systems and fast CPU response times and a comprehensive internal memory.

2. The system shall be generic so that there will be alternative service providers for maintenance, engineering and commissioning. The technology shall be compact and powerful enough so the respective requirements are fulfilled.

3. The CPUs shall be able to process special tasks in the automation system using high level languages. The programming options shall be based on functional block diagrams (FBD), ladder logic (LAD) and statement lists (STL).

4. The I/O modules of the PLCs shall be able to be used for the distributed

connections of remote I/Os as well as in the programmable controller itself. PLCs and I/O modules shall be from same PLC family.

5. The systems shall support online removal and insertion of I/O modules and interface modules without having to switch off the power supply.
6. The system shall be structured in a modular way.
7. The system shall provide for online programming and changes to the programming.
8. PLCs shall have onboard Ethernet communication ports.

B. PLCs General:

1. If more than one microprocessor based PLC is provided, each shall capable of standalone operation. In the event of a communication failure, the PLCs shall be capable of both controlling the connected equipment and switching to preset default settings.
2. All the PLCs provided shall be from the same manufacturer.
3. Each PLC shall have a minimum of 20% spares for each type of I/O.
4. Chassis/ DIN rail/ racks shall be provided of the size and quality required to house the cards. There shall be a minimum four spare slots for future expansion.
5. The requisite power supplies shall be provided with a minimum of 40% spare capacity.
6. PLC shall be provided with conformal/ anti corrosive coating, to protect PCB and electronic components from environmental stresses.
7. EPROM based memory storage for backup shall be provided however the controllers shall be able to perform without memory cards.

C. Hardware for PLCs:

1. The master PLCs shall include the minimum following hardware and software:
   a) Redundant High Performance CPU
   b) Redundant Power Supply
   c) Digital Input Module
   d) Digital Output Module
   e) Analogue Input Module

f) Analogue Output Module

g) Redundant Interface Communication Module

h) Mounting Rack, if required

i) Communication Port

j) Appropriate PLC operating system software, etc.

2. Microprocessor (CPU):

a) CPU processing time - 100 microsec per instruction (min)

b) Working memory - 50 % spare capacity shall be available after programming & commissioning

c) Number of FM, minimum one or based on actual site requirement

d) Number of CP (LAN) one or based on actual site requirement

e) Battery backed CMOS RAM program memory with battery back-up.

f) Built-in PID control.

g) Real time clock and calendar function – time synchronization with master clock, real time alarm and time stamping shall be available.

h) Remote programming capability via the data communications network.

i) An additional memory card, flash EPROM type, shall be provided.

3. General Specifications:

Degree of Protection	IP20 to IEC 60529
Ambient Temperature • With horizontal mounting	0 to 60°C
Relative Humidity	5 to 95%, no condensation (RH severity level 2 in accordance with IEC61131-2
Electromagnetic Compatibility	EU directive 89/336/EWG; Per EN 50082-2 noise immunity testing per IEC 61000-4-2, 61000-4-3, IEC 61000-4-4, IEC 61000-4-5, IEC 61000-4-6, Emitted interference according to EN50081-2, tested

	according to EN 55011, class A, group 1
Mechanical Rating • Vibration tested according to/ tested with	IEC 60068, part 2-6/10 up 58Hz; constant amplitude 0.075mm; 58 to 150 Hz; constant acceleration 1g; Oscillation period: 10 frequency cycles per axis in each direction of the three axes
• Shock, tested according to/ tested with	IEC 60068 Part 2-27/ half-sine strength of impact 15g (peak value), duration 11ms

4. Inputs / Outputs Modules:

a) Each PLC shall have field I/O expandable capability.

b) Each PLC shall be capable of handling a minimum of 256 I/Os.

c) Minimum analogue inputs:

i) 12 bit, ± 0.1% accuracy

ii) Point configurable 1-5 V dc, 0-10 V dc or 4-20 mA dc

iii) Provision for board calibration (span, zero adjustments)

iv) 4/6/8 channel inputs per card

v) Wire break diagnostic/ status alarm available

d) Minimum analogue outputs:

i) 12 bit, ± 0.1% accuracy

ii) Point configurable 1-5 V dc, 0-10 V dc, 5 mA load, or 4-20 mA dc, 650 ohm load.

iii) Provisions for board calibration (span, zero adjustments)

iv) 4/6/8 channel outputs per card.

e) Minimum digital inputs:

i) Nominally 230 V ac isolated/ 24 V dc

ii) Opto isolated

iii) where necessary, provide 24 V dc digital inputs

iv) LED status indicators per channel

v) 16/32 channels per card

f) Minimum digital outputs:

i) Nominally 230 V ac isolated/ 24 V dc

ii) where required, provide 24 V dc digital outputs

iii) Complete with interposing relays and LED indication, rated for the load conditions. Relays to have form C outputs.

iv) LED status indicators per channel

v) 16 outputs per card

g) All process I/O shall include surge protection as per IS standard.

h) All I/O connections to have plug or screw terminations.

i) PLCs shall have a watchdog circuit and LEDs for generating an alarm when the microprocessor fails.

5. System Interface:

a) Provide, as a minimum, the following interface:

i) One Ethernet port.

ii) Two high speed, parallel ports for additional local I/O racks, if required.

iii) Two RS-485 ports for modbus communication for digital power meter communications etc.

6. Minimum remote I/O communication:

a) Provide all required hardware and software required to allow redundant Ethernet communications with remote I/Os. The remote I/Os communication speed shall be a minimum of 10 MBPS.

7. PLC programming cables

a) PLC programming cables shall be provided for uploading PLC logic and data.

8. All required additional hardware for PLCs:

a) All the required communication cabling between the PLCs and the

remote I/O panels (if any) shall be provided.

9. Power Supply:

   a) The power supply at 230 V AC shall be passed through power conditioning devices to protect the PLC's components.

   b) PLC power supply modules suitable for 24 V DC or 230 V AC inputs shall be provided.

   c) A battery back-up shall be provided, integral to the CPU, capable of storing and maintaining all configured software in the memory for a minimum of two months.

10. PLC Software Packages:

   a) Provide a user-friendly software package with distribution media (CDs/ DVDs), documentation and end user licenses for the PLC systems.

   b) Provide suitable professional software packages to allow online and offline program development, testing and documentation utilizing a control orientated, menu driven, easy-to-use programming technique.

   c) Include diagnostic programs to allow on-line hardware testing of components.

   d) Provide programming and diagnostic software for use on the PCs supplied. Software shall be compatible with the Windows operating system installed in PC.

   e) Development software to run on PC systems connected to the Ethernet high speed, peer to peer communication system, LAN system or WAN system. Uploading and downloading of CPU programs shall not cause interruption of the SCADA/HMI system.

11. I/O Processor Programs:

   a) PLC Programming Environment. The PLC programming software shall have

      i) All five IEC languages for programming as per IEC 61131-3.

      ii) Inbuilt user-friendly function blocks, multitasking capabilities and functional views to map applications to the process.

      iii) Inbuilt embedded PLC simulators to debug complete programs.

      iv) Use function blocks of I/O management libraries to simulate

inputs.

v) PLC and module diagnostic through the configuration editor.

vi) Integrated system and application diagnostic accessible through the built-in diagnostic viewer

vii) The capability for graphical and animated views of the process.

viii) Features for the import/export of applications in XML format.

ix) Use embedded diagnostics for reducing downtime.

x) Inbuilt derived function blocks and ladder logic.

xi) Features to arrange PLC data according to processes in the data structure and multi-dimensional arrays.

xii) Quick access to additional documents about application through hyperlinks.

b) All installed and developed software to be completed as per IEC 61131-3 and shall be provided with support for a minimum of five years.

12. Spare Parts (as per supply and minimum 20% OR 01 No., whichever higher of the installed items per each type):

a) Provide spare cards/modules and equipment as follows:

i) Digital input cards

ii) Digital output cards (c/w interposing relays per output)

iii) Analogue input card

iv) Analogue output card

v) CPU

vi) Power supply

vii) Fibre / copper media converter

viii) Panel power supply (24 V dc)

ix) Back plane

x) Spare CB (1A, 2A and 5A)

xi) Surge protectors (Ethernet)

b) Spares to be provided for seamless and based on BMC requirement.

2.05 Minimum Specification for SCADA:

A. General:

1. The SCADA system shall comprise operations and programming work stations, printers and all associated equipment with the features specified inbuilt.

B. Process Analysis:

1. A fault-finding process analysis function shall be included in the package.

C. Compatibility with PLC programming software:

1. The database for the PLC and SCADA/HMI software shall be common.

2. The entire PLC - SCADA and HMI automation system shall be sourced from a single vendor.

D. Integrated XML Web Service:

1. A read-only web service interface shall be integrated into SCADA to provide access to all tags, alarms and trend information.

E. Easy Configuration

1. The SCADA and HMI system shall be easy to configure.

F. System Hardware:

a) SCADA station with historical data storage shall have the following minimum features

i) Intel XEON Quard-Core Processor upto 4.5GHz or higher

ii) 4 GB DDR2 SDRAM memory

iii) Two 1TB hard drives (15 K rpm, RAID level 5), expandable up to 4TB

iv) CD/DVD RW drive; 24 X speed

v) Extended keyboard USB, 8 hot keys

vi) 22” LED display; HD resolution with internal speaker

vii) Mouse USB, two buttons and scroll, optical type

viii) 10/100 Mbps Ethernet port

ix) Wireless network adapter card

x) Two front and four rear USB ports

xi) Serial RS232 ports

xii) One spare PCI slot

xiii) Compatible with all SCADA software

xiv) Latest antivirus software (Quick Heal / Norton / McAfee)

xv) Drivers to suit applications as required

xvi) Factory system recovery CD

xvii) Microsoft Windows Server (Latest Version)

xviii) Microsoft Office Standard Edition (Latest Edition)

xix) The SCADA server shall be capable to store the data of five years.

xx) Spike guard: 5-outlet spike guard complete with built-in surge protector and fuse shall be provided

b) Network black and white printer to be complete with the following features as minimum:

i) Type: Laser, scanner, copier, printer all in one

ii) Paper size: A3/ A4

iii) Speed: Minimum 20 page/min.

iv) Memory: Minimum 128 MB.

v) Resolution: black 1200 x 600 dpi

vi) One black toner cartridge

vii) One port USB compatible with USB 2.0 specification

viii) 250 paper input capacity

ix) Separate power on/off and form feed switches.

c) Uninterruptible Power Supply (UPS):

i) Type: Industrial Grade, On line, double conversion

ii) Indoor installation with IP21 rating

iii) UPS shall be user friendly

iv) Input power: 230V, 1ph, 50Hz

v) Fan cooled

vi) Design ambient temperature: 45^{o}C

vii) Regulation: Less than +/- 1% at static condition

viii) Inverter technology: IGBT based Pulse Width Modulation (PWM) type

ix) Overload period: 110% for 30min., 150% for 1min.

x) Load power factor: 0.8 to unity

xi) Backup period: 120 min. @ 100% load

xii) Static bypass switch required with transfer time less than 5 msec.

xiii) Manual bypass switch with make before break facility shall be provided

xiv) Battery type: Sealed maintenance free (SMF) lead Acid Type.

xv) Inbuilt isolation transformer to provide galvanic isolation to load

xvi) After failure of Main supply, connected load shall be fully operable without any disturbance.

xvii) UPS shall have indication of Mains ON, Inverter ON/ battery output, Battery charging, Low battery imminent, overload as minimum

xviii) Racking system shall be provided for batteries

xix) UPS shall be capable to operate the PLC and HMI from instrumentation panel, CCTV surveillance system and SCADA server for a **minimum of 120 min.** without any disturbance, after failure of mains power.

d) Minimum applications for SCADA:

i) For the SCADA screens, refer to Section 2 Process Narrative.

ii) Provide at least the following SCADA functions:

- Menu
- Alarms on a priority basis
- Role/ level based access control
- Historical data

- Report generation
- Events log

iii) Provide SCADA tags require for this project including soft and hardwired tags and 50% spare tags.

- A professional SCADA developer license -1 No.
- A professional SCADA runtime license – 2 Nos.

iv) Provide at least one copy of each of the following:

- Suitable XL reporter professional (two users)
- Suitable site level Historian Edition with capacity for 50% spare tags.

G. HMI:

A 12" colour HMI shall provide facilities for both process control and monitoring. The facilities provided shall include plant status monitoring, plant start/stop command and process set- point adjustments.

All screens shall display the following basic information:

1. Date and Time:
   a) Located in header using size 16 Arial font
2. Mimic Title:
   a) Located at the top centre of the screen using size 20 Arial font
3. Access Status:
   a) Located at the top right of the screen using size 20 Arial font
   b) To display current user's access level (i.e. Default, Operator, Supplier, Supervisor.)
4. Navigation Keys
   a) At the foot of each screen and positioned above the alarm banner
5. Alarm Banner
   a) At the foot of each screen (except the Alarm Page)
   b) To display the 4 most recent alarms
6. As far as possible, HMI screens shall have a common 'look and feel'. Screens

shall consist of three main types: Overview Mimics, Details Mimics and Pop-up Mimics.

a) Overview Screens

i. Overview screens shall be gateways to the Details Screens

ii. Detailed information shall not be displayed by the overview screen although the most important status information may be indicated

b) Details Screens

i. Details screens shall display the detailed status of all dynamic plant equipment

ii. All required control and monitoring facilities shall be available from these screens

c) Pop-up Screens

i. Pop-up screens shall be partial page screens selected from the Details Screens and shall normally be associated with plant items

ii. The system shall be structured to allow all full-page mimics to be selected within 4 selections from any other screen in the system

iii. Plant equipment with only one option shall go directly to its appropriate pop-up when selected

iv. Pop-up screens shall not obscure the plant item under control

v. Pop-up windows shall close when the originating screen is closed

7. A screen-based warning window will be displayed, and the action prevented if the SCADA operator tries to enter a process control instruction that is not valid.

8. Screen Navigation:

a) Where feasible, the designer shall avoid exceeding 3 depth levels of screens (including the overview page) for ergonomic operation reasons

b) Screen navigation shall operate as mouse click buttons and allow direct access to screens

Note: The Contractor shall always consider the latest software and hardware available at the point of implementation.

2.06 Communication System for PLC & SCADA/HMI:

A. General:

1. Communication hardware and software shall be supplied and be compatible with all PLCs i.e. the communication shall be based on an open bus protocol system.
2. The PLC, SCADA and HMI software shall be compatible with each other.

B. Hardware:

1. Provide industrial grade Ethernet managed switches (EMS), industrial grade, IP20 compatible from an approved manufacturer.
2. Provide spare Ethernet switches.
3. Operating temperature shall be 0-50 deg C.

C. Software:

1. The PLC to computer communication software shall be an off-the-shelf, standard communication system.
2. Suitable drivers for the selected PLC model shall be provided, in the selected SCADA/HMI software for the ease of communication between PLC and SCADA/HMI.

D. SCADA and Printer communication:

1. The SCADA system and printers shall communicate continuously through Ethernet switches.
2. Printing shall possible only from SCADA system
3. Panel mounted HMI development platforms and SCADA platforms shall be the same

E. LAN Structures:

1. Switches and routers shall be used for setting up a LAN. The network functions of Windows 2013 Server or higher shall be used. The local network of the process control system shall be designed as an Ethernet LAN in accordance with IEEE 802.3 / 802/3u with 10/100 Base-T. If present, the individual network nodes shall be connected to the LAN through switches.
2. Switches shall feature auto sensing functions for when components with different transmission rates are used (10 Mbit/s or 100 Mbit/s).Central network management shall be possible by means of the simple network management protocol. Network components such as gateways, file servers

and bridges shall be monitored and administrated by means of a suitable network management program. This program shall facilitate maintenance and service in extensive networks.

3. Conventional data transmissions shall be either electrically, via twisted-pair cables and RJ 45 ports (as per standard - ISO/IEC11801/ preferably CAT 6 cable), or via multi-mode fibre-optic cables.

4. Components in outdoor panels shall have IP65 protection and be able to withstand operating temperatures between 15°C and 60°C with condensation.

F. Bus System:

1. Open bus systems shall be used on the field level and industrial Ethernet shall be used for interlinking automation systems and for connecting them to the control centre. Only segment coupler types from the supplier's product range of automation systems shall be used.

2. Linking distributed stations over WAN shall be implemented by means of internet-based procedures based on the TCP/IP protocol. A suitable open bus protocol shall be used in order to remain within the technological product range. The IPSec security standard shall be applied when using open bus protocols and the internet.

3. Error messages shall be broadcast by means of the following mechanisms:

a) Text messages direct from the PC

b) Voice messages

c) Announcing messages through PA system

G. Optical Fibre Cable:

1. Fibre-optic cable shall be single or multi-mode. Multi-mode fibre optic cable shall be used for distances of less than 500 metres and single mode used for distances greater than 500 metres. The fibre optic cable shall be unitube cable with fibre identification, length marking and contrast colour marked.

Acceptance criteria for fibre cable: The fibre optic cable shall be subject to tensile tests, crush tests, impact tests and torsion tests as per IEC 794 -1- E4 **Workstation / Equipment patch Cords – 5 Metres**

Component	**Minimum Required Specification**
Type	Unshielded twisted pair, category 6, TIA / EIA 568-B.2

Conductor	24 AWG 7 / 32, stranded copper
Length	5 m
Plug Protection	Transparent slim line series boot
Warranty	25-year component warranty
Category	Category 6
Housing	Clear polycarbonate
Terminals	Phosphor bronze, 50 micron gold plated over selected area and gold flash over remainder, over 100 micron nickel under plate
Load bar	PBT polyester
Jacket	PVC
Insulation	Flame retardant polyethylene

2.07 Typical I/O list

Part A: Signal exchanges between PLC & MCC for drive control

Sr. No.	**From**	**To**	**Signal Description**	**Remarks**	**PLC Signal Type**
A	**FOR HT UNI-DIRECTIONAL MOTOR DRIVES**				
	PLC	SWGR	Command To Start	CMD to SWGR.	DO
	PLC	SWGR	Command To Stop	CMD to SWGR.	DO
	SWGR	PLC	Motor Running	Feedback to PLC	DI
	SWGR	PLC	Motor Stopped	Feedback to PLC	DI
	SWGR	PLC	Motor Tripped (Thermal Overload)	Feedback to PLC	DI
	SWGR	PLC	Motor Ready To Start (By anding Thermal O/L not Operated/ Control Supply available/ SWGR. Trip coil healthy)	Feedback to PLC	DI

Sr. No.	From	To	Signal Description	Remarks	PLC Signal Type
	SWGR	PLC	Breaker In Service	Feedback to PLC	DI
	SWGR	PLC	Breaker In Remote	Feedback to PLC	DI
	SWGR	PLC	Breaker In Test	Feedback to PLC	DI
	SWGR	PLC	Breaker Lockout Relay Reset	Feedback to PLC	DI
	SWGR	PLC	Motor Current (4-20 mA DC)	Feedback to PLC	AI
	SWGR	PLC	Motor KW (4-20 mA DC)	Feedback to PLC	AI
	LPB	SWGR	Emergency Stop Command	Wired to SWGR.	-
	LPB	PLC	LPB Emergency Stop Command Operated	LPB Stop Operated Feedback to PLC	DI
B	**FOR LT UNI-DIRECTIONAL MOTOR DRIVES**				
1	PLC	MCC	Command To Start/ Stop	CMD to MCC	DO
2	MCC	PLC	Motor Running/ Stopped	Feedback to PLC	DI
3	MCC	PLC	Motor Tripped (Thermal Overload)	Feedback to PLC	DI
4	MCC	PLC	Motor Ready To Start (By anding Thermal O/L not Operated/ Control Supply available/ MCC not isolated)	Feedback to PLC	DI
5	MCC	PLC	Motor Torque Switch Operated**	Feedback to PLC	DI

Sr. No.	From	To	Signal Description	Remarks	PLC Signal Type
6	MCC	PLC	Motor Current (4-20 mA DC)	Feedback to PLC (For Motor KW> 30)	AI
7	MCC	PLC	Local/ Remote Selection Switch in REMOTE mode	Feedback to PLC	DI
8	LPB	MCC	Emergency Stop Command	Wired to MCC	-
9	LPB	PLC	LPB Emergency Stop Command Operated	LPB Stop Operated Feedback to PLC	DI
10	N/E SWGR.	PLC	N/E Bus Undervoltage	Feedback to PLC (Common for all applicable N/E Swgr. Service drives)	DI
	**: Applicable for selected motorised drives only. Bidder to state.				
B	**FOR LT UNI-DIRECTIONAL VFD DRIVES**				
1	PLC	VFD	Command To Start/ Stop	CMD to VFD	DO
2	VFD	PLC	Motor Running/ Stopped	Feedback to PLC	DI
3	VFD	PLC	Motor Tripped (Thermal Overload)	Feedback to PLC	DI
4	VFD	PLC	Motor Ready To Start (By anding Thermal O/L not Operated/ Control Supply available/ MCC not isolated)	Feedback to PLC	DI
5	VFD	PLC	Speed Feedback (4-20 mA DC)	Feedback to PLC	AI

Sr. No.	From	To	Signal Description	Remarks	PLC Signal Type
6	PLC	VFD	Speed Control (4-20 mA DC)	CMD to VFD	AO
7	VFD	PLC	Motor Current (4-20 mA DC)	Feedback to PLC (For Motor KW> 30)	AI
8	VFD	PLC	Local/ Remote Selection Switch in REMOTE mode	Feedback to PLC	DI
9	LPB	VFD	Emergency Stop Command	Wired to MCC	-
10	LPB	PLC	LPB Emergency Stop Command Operated	LPB Stop Operated Feedback to PLC	DI
C	**FOR MOV WITH BI-DIRECTIONAL MOTOR DRIVE**				
1	PLC	MCC	Command To Open/ Close	CMD to MCC	DO
2	MCC	PLC	Motor Tripped (Thermal Overload)	Feedback to PLC	DI
3	MCC	PLC	Motor Ready To Start (By anding Thermal O/L not Operated/ Control Supply available/ MCC not Isolated)	Feedback to PLC	DI
4	Actuator	PLC	Open Limit Switch Operated	Feedback to PLC	DI
5	Actuator	PLC	Close Limit Switch Operated	Feedback to PLC	DI
6	Actuator	PLC	Open Torque Switch	Feedback to PLC	DI

Sr. No.	From	To	Signal Description	Remarks	PLC Signal Type
			Operated		
7	Actuator	PLC	Close Torque Switch Operated	Feedback to PLC	DI
8	Actuator	MCC	Open Limit Switch Operated	For power cut-off in MCC	-
9	Actuator	MCC	Close Limit Switch Operated	For power cut-off in MCC	-
10	Actuator	MCC	Open Torque Switch Operated	For power cut-off in MCC	-
11	Actuator	MCC	Close Torque Switch Operated	For power cut-off in MCC	-
12	MCC	PLC	Local/ Remote Selection Switch in REMOTE mode	Feedback to PLC	DI
13	LPB	MCC	Emergency Stop Command	Wired to MCC	-
14	Actuator	PLC	Position Feedback (4-20 mA DC)	Feedback to PLC (For Inching services)	AI
15	N/E SWGR.	PLC	N/E Bus Undervoltage	Feedback to PLC (Common for all applicable N/E Swgr. Service drives)	DI

Notes for Typical I/O list:

1. This is typical I/O list including minimum I/O requirement for IPS, Contractor / Supplier has to do original I/O count based on their design.

2. All 'DI' signals to be interfaced to PLC are Potential Free Contact (PFC) type.

3. In case of Uni-directional & Bi-directional motor drives, all 'DO' commands from PLC to SWGR./ MCC/ VFD are 24 V DC logic level type. 24 V DC IPR shall be located in SWGR./ MCC/ VFD & in bidder's scope of supply.

PART B: PROCESS SIGNALS MINIMUM REQUIRED FOR INTERFACING WITH PLC

1) HT Pump discharge pressure and common discharge header pressure (AI : 4-20 mA)

2) Wet well level (AI : 4-20 mA)

3) Dry well sump level switch (DI : Potential Free Contact)

4) HT Pump individual discharge flow (AI : 4-20 mA)

5) HT Pump bearing and Motor winding and bearing temperature (RTD Input)

6) HT Pump and Motor Vibration (AI : 4-20 mA)

PART C: PROCESS LOCAL INDICATORS MINIMUM REQUIRED FOR LOCAL MONITORING

1) Pressure indicator at each pump/ blower/ fan discharge and common discharge

2) Level display indicator at each storage tank/ sump.

END OF SECTION 3

SECTION 4 – FIELD INSTRUMENTS AND DEVICES

PART 1 - GENERAL

1.01 Reference:

A. Section 1 - Control and Instrumentation, applies to and governs the work of this Section.

1.02 Work Included:

A. Supply, installation, testing and commissioning of all field instruments and devices and all other field devices indicated on the control and instrumentation Drawings.

B. The intent of field instrument summary list is just to summaries and not to define all instruments required in the project.

C. Supply of the hardware required for proper installation of instruments.

D. The Drawings, Datasheets and Specifications are intended to set the acceptable minimum standard. Ensure that the installed field instruments and devices are trouble-free and meet their intended performance.

1.03 Related Work by Other Divisions:

A. The following related work is covered elsewhere in the contract documents:

1. Mechanical Specification
2. Electrical Specification

1.04 Alternatives:

A. Not applicable for this section.

1.05 Submittals:

A. Submit drawings, product datasheets and installation drawings, as specified in Section 1 and As-Built Drawings.

B. Submittals shall show selected models and options from the suppliers' literature and catalogues.

1.06 Codes and Standards:

A. The applicable standards as referred in Section 1 established by the Bureau of Indian Standards (BIS), IEC, CE, BS, ANSI and ASTM govern the materials and workmanship employed in the manufacture of all items.

B. Where provisions of the pertinent codes and standards conflict with these

Specifications, Drawings or with each other, comply with the more stringent provision.

C. Use the latest issue of standards.

PART 2 - PRODUCTS

2.01 General:

A. For transmitting instruments, the output signal shall be isolated 4-20 mA DC.

B. Pressure gauges and transmitters for wastewater application shall be provided at each pump suction and discharge line and at pumps common header.

C. Diaphragm seal complete with flushing connection and clean out feature to be provided for all gauges and pressure transmitters. All materials shall be SS316 construction. Seals provided with continuous duty type diaphragm, liquid filling screw, bleed screw, 46mm Φ gauge connection.

D. Two Way manifold with one drain shall be provided with each Pressure Gauge.

E. Locations where gauges to be mounted at 2.0 m elevation above the floor, 100 mm dial size gauges shall be provided.

F. Gauges on suction side of pumps shall be compound type.

G. One (1) No. Radar type level transmitter shall be provided for each " Wet Well Compartment."

H. Electromagnetic type flowmeter shall be provided at Individual pump discharge line (1000 mm) - 6 Nos.
Also, 1 No. spool pipe piece of each line size shall be provided in view of removal of flowmeter required for cleaning maintenance/ replacement.

I. Remote display for electromagnetic flowmeters shall be suitably located at nearby access floor or PLC panel room.

J. For all electronic instruments, transmitters shall be microprocessor based, suitable for operation on 230 V AC +/-10% AC or 24V DC power supply with 4-20 mA DC linear, isolated output or 4-20mA DC loop powered type. Remote calibration and configuration shall be easily possible for all electronic instruments.

K. Provision of 24V DC supply for field instruments shall be from the PLC Control Panel.

L. All field instruments shall be CE marked and instruments mounted in hazardous area shall have ATEX approval.

M. Surge protection devices as per IEC 61643 shall be provided to protect the field instruments from external surges.

N. Transmitter cum indicator unit shall be compatible with field mounted transducer.

O. High signal resolution shall be for optimum turns down ratio.

P. User configurable operation menu shall be provided with password protection.

Q. Refer specification data sheets for details of minimum requirement.

PART 3 -EXECUTION

3.01 Examination:

A. Inspection:

1. Prior to installation of the work in this Section, carefully inspect and verify that all other work is complete to a point where this installation may properly commence.

B. Discrepancies:

1. In the event of a discrepancy, immediately notify the Engineer. Do not proceed with installation in areas of discrepancies until all such discrepancies have been fully resolved.

3.02 Installation:

A. Analogue signal cables armoured type with twisted shielded pairs shields to be terminated and grounded to clean instrument ground bar at Control Panels only.

B. Install all instruments and devices, hardware, wiring, impulse piping, accessories etc. such that they shall not be in walkways or cause obstacles during normal operation. Installations shall be easily accessible, and the required maintenance space shall be available. They shall not interfere with the operation of other instruments and items of plant.

C. Each device shall be tagged with a permanent stainless-steel nameplate indelibly marked with the device identification tag.

D. Provide proper and secured support.

E. Any area of interference between instruments and surrounding structures shall be promptly reported to the Engineer. Corrective measures shall be taken after final approval of Engineer.

F. Ensure that instruments function properly after installation and shall be easily readable.

3.03 Testing:

A. Test and calibrate all instruments.

END OF SECTION 4

SECTION 5 – GAS MONITORING SYSTEM

PART 1 - GENERAL

1.01 Reference:

A. Section 1 - Control and Instrumentation, applies to and governs the work of this Section.

1.02 Work Included:

A. Supply, testing and commissioning of all portable gas monitoring systems, one for each pumping station.

B. Supply of all required hardware for the proper functioning of the gas monitoring systems and ensuring the systems are trouble-free and meet their intended performance.

C. Supply wall mounted cabinets with glass doors to house the portable gas detectors.

1.03 Related Work by Other Divisions:

A. The following related work is covered elsewhere in the contract documents:
Electrical Specifications

1.04 Alternatives:

A. Not applicable for this section.

1.05 Submittals:

A. Submit drawings and product data sheets indicating the selected models and options and As-Built Drawings.

1.06 Codes and Standards:

A. The applicable standards established by the Bureau of Indian Standards govern the materials and workmanship employed in the manufacture of these items.

B. Where provisions of the pertinent codes and standards conflict with these Specifications and Drawings or with each other, comply with the more stringent provision

C. Use the latest issue of the standards

PART 2 - PRODUCTS

2.01 Gas Detection Systems:

A. Multi-gas monitoring systems shall be versatile and capable of detecting H_2S, CH_4, O_2, CO, SO_2 and NOx for a wide variety of hazardous and confined space applications.

B. Portable multi-gas monitoring systems shall be housed in a rugged, impact-resistant case to provide good performance and durability in harsh environments.

C. There shall be easy access to the pump, sensors, filter and battery compartment without exposing electronic components to potential damage. A minimum three metre drop test shall be performed on instrument. Rubberised housings shall be provided to protect from accidental drops.

D. Other standard features shall include:

1. Peak/hold readings
2. A minimum two-year all inclusive warranty

2.02 Specifications:

A.	Case	High – visibility, impact resistant composite and IP67 shall be tested and approved.
B.	Sensors	A minimum four-gas configuration including oxygen, methane, hydrogen sulphide and carbon monoxide.
C.	Sampling pump	Capable of drawing gas for monitoring from the environment. Capable of remote sampling from a 15 metre distance using a probe.
D.	Measuring ranges	CO range: 0-1000 ppm in 1 ppm increments H_2S range: 0-100 ppm in 1 ppm increments O_2 range: 0-30% volume in 0.1% increments CH_4 range: 0-100% LEL in 1% increments SO_2 range: 0-100 ppm in 1 ppm increments NOx range: 0-100 ppm in 1 ppm increments Features: LEL (lower explosive limit) over-range protection.

E.	Power source	Lithium-ion battery (ability to re-charge in instrument).
F.	Runtime	Minimum 12 hours – instrument with pump (non-alarm).
G.	Display	Large LCDs shall provide simultaneous and continuous readout of all four gases. Large, high-contrast characters, graphic icons and amber backlight shall provide clear display visible in low-light conditions.
H.	Alarms	Vibrating, 90dB audible and ultra-bright visual alarms. High/low, STEL, TWA, and low battery alarms.
I.	Data logging	Up to 50 hours of data logging capability
J.	Temp range	Ambient to 50^{o}C

PART 3 - EXECUTION

3.01 Handling and Storage:

A. Hand-held gas detection equipment shall be brought to the point where detection of H_2S, O_2, CH_4 and CO is required.

B. Store portable gas monitoring sensors in wall mounted cabinets at dry locations subject to the approval of the Engineer.

Provide a warning label above the wet well near the pump hatch, about the availability of ‘Hand-held gas detection equipment’ in the pumping station

END OF SECTION 5

LIST OF APPROVED MAKES

LIST OF APPROVED MAKES

LIST OF APPROVED MAKES - MECHANICAL

Sr. No.	Description	Vendor/Manufacturer/Make
1.	Main pumps	M/s KBL M/s Grundfos M/s Wilo Mather-Platt M/s Xylem Pump Motor: As per Pump Manufacturer
2.	E O T Crane	M/s Eddy Cranes M/s Electromech M/s Brady Morris M/s SMACO M/s Hercules Hoists Ltd.
3.	Knife Gate Valve	M/s Jash M/s VAG M/s Orbinox M/s Fouress M/s VAAS M/s Dezurik M/s AVK
4.	Sluice Gates	M/s Jash M/s Rodney hunt M/s Ham Baker M/s Parchure Engineers Pvt. Ltd. M/s Armco Sluice Gates
5.	Non-Return Valve	M/s IVC M/s KBL M/s VAG M/s Orbinox M/s Dezurik M/s Fouress

		M/s AVK
6.	Mechanical Screen	M/s Jash (Mahr Maschinenbau) M/s Huber M/s Auricent M/s Aqseptence (M/s Johnson screens) M/s Head works M/s Parchure Engineers Pvt. Ltd.
7.	Dismantling Joints	M/s Viking Johnson M/s Peleecon Linker M/s Vag M/s Anant Engineers & Fabricators. M/s Dresser
8.	Centrifugal Blowers	M/s Pullman Enginnering Systems Pvt. Ltd. M/s Eminent Blowers M/s Deepti Airsystems & Fabricators Pvt.Ltd
9.	Electric Hoist	M/s Eddy Cranes M/s Electromech M/s Brady Morris M/s SMACO M/s Hercules Hoists Ltd.
10.	Elevator	M/s Schneider M/s Otis M/s Thyssenkrupp
11.	Electric Actuator	M/s Auma M/s Rotork M/s Limitorque

12.	Pipes and Fittings	M/s Mukat pipes M/s Lalit Profiles or equivalent as per Schedule F (in Volume IV).
13.	Propeller Fan	Kruger, Nicotra, Systemair, Caryaire
14.	Air Conditioning	M/s Onida, M/s Voltas, M/s Whirlpool, M/s Caryair, M/s Daikin, M/s Blue star
15.	Motors	M/s GEC M/s Siemens M/s ABB M/s Crompton M/s NGEF M/s Jyoti M/s KEC M/s Shinko Japan M/s BHEL M/s Bharat Bijli M/s Alstom M/s Kirloskar

LIST OF APPROVED ELECTRICAL VENDORS

List of Approved makes for Electrical Equipment / Items:

Sr. No.	Description	Vendor/Manufacturer/Make
1.	Transformers	M/s ABB M/s Siemens M/s Crompton Greaves Limited M/S Volt Amp M/s Kirloskar Electric
2.	HV/MV Switchgear (22kV/6.6kV)	M/s ABB M/s Siemens M/s Schneider Electric M/s L&T And above mention vendor System integrators can also manufacture the panels.
3.	Protective Relays (Numerical type)	M/s ABB M/s Schneider Electric M/s GE M/s Siemens M/s Areva T&D M/s EasunReyrolle
4.	Current Transformers	M/s ABB M/s Siemens M/s CGL M/s Kappa M/s Ind Coil
5.	Voltage Transformers	M/s ABB M/s Siemens M/s CGL M/s Kappa M/s Ind Coil
6.	PCC's/MCC's/LV(415V)Switchgears& Control gears	M/s Schneider Electric M/s ABB M/s Siemens M/s L&T

Sr. No.	Description	Vendor/Manufacturer/Make
		Only the system integrator of above mentioned makes will be acceptable.
7.	LT Power Capacitors	M/s ABB, M/s Universal M/s Madhav M/s Shreem M/s EPCOS
8.	Variable Frequency Drives	M/s Siemens M/s ABB M/s Schneider Electric M/s Amtech M/s Danfoss
9.	Lighting Fixtures and Accessories	M/s Philips M/s ABB M/s Bajaj M/s Wipro M/s GE
10.	Power Cables (HT & LT) and Wires	M/s Universal Cables M/s Polycab M/s KEC international ltd M/s Finolex M/s Cable Corporation of India Ltd
11.	MLDB's, LDB's, SDB's, MCB's, RCCB's	M/s L&T M/s Standard M/s Legrand M/s Siemens
12.	Switches, Plugs, Sockets	M/s Legrand M/s Havells M/s Anchor M/s Cona
13.	Ceiling Fans	M/s Havells M/s Crompton M/s Orient M/s Bajaj

Sr. No.	Description	Vendor/Manufacturer/Make
		M/s Usha
14.	Meters	M/s AE M/s Rishabh M/s Meco M/s Enercon M/s IMP
15.	Indicating Lamps	M/s Vaishno M/s Tecknic M/s Raas M/s Siemens
16.	Push Buttons	M/s Vaishno M/s Tecknic M/s Raas M/s Siemens
17.	Glands	M/S Comet M/S Dowell
18.	Insulators	M/S BHEL M/S WS M/S Jayshree
19.	Lightning Arrestors	M/S WS M/S Jayshree M/S Elpro M/S Oblum
20.	Lighting pole	M/S Bajaj M/S Bombay Tubes and Poles M/S Valmont M/S India Electric Poles
21.	Battery charger	M/S Chhabi Electrical M/S HBL Power Systems M/S Amara Raja M/S Universal Instruments M/S Mass-tech Controls
22.	Motor (HT)	M/S Siemens M/S BHEL

Sr. No.	Description	Vendor/Manufacturer/Make
		M/S Crompton Greaves M/S ABB M/S Kirloskar
23.	Distribution Boards (other than MLDB, MPDB, MOVDB) / Panels / Enclosures / JB / Marshalling Panel	M/S Hensel M/S Rittal M/S C&S M/S Legrand M/S Eldon
24.	APFC Panel (LT)	M/s ABB, M/s Universal M/s Madhav M/s Shreem M/s EPCOS
25.	Battery (Ni – Cd Battery)	M/s HBL Power Systems Ltd. M/s Hoppecke M/s AmcoSaft
26.	Diesel Generator	Cummins make engine and Stamford make Generator

LIST OF APPROVED MAKES

LIST OF APPROVED MAKES - INSTRUMENTATION

Sr. No.	Description	Vendor/Supplier/Make
1	Level Transmitters	Emerson ABB Siemens Endress+Hauser Krohne Marshall
2	Level Switches	Pune Techtrol Magnetrol Siemens Endress+Hauser SBEM
3	Flow Meters-Transmitters	Emerson ABB Siemens Endress+Hauser Krohne Marshall SBEM
4	Pressure Gauges	WIKA GIC AN Instruments Altop Industries M Guru Controls
5	Pressure Transmitters	Nivo Control ABB WIKA Emerson Foxboro
6	Temperature Scanners	Masibus Electronet Equipments Lektrotek Systems
7	Vibration Monitoring System	Bently Nevada

Sr. No.	Description	Vendor/Supplier/Make
		Emerson Forbes Marshall IFM Electronic Metrix Instrument Rockwell Automation
8	Junction Box	Hensel Electric Industrial Switchgear & Controls Kaysons Techno Equipments Pepperl+Fuchs (I) PVt. Ltd. Stahl Rittal Tyco CEAG flameproof control
9	UPS	APC HI-REL Numeric Power System
10	Batteries	Amar Raja HBL NIFE AMCO Exide
11	Cables/Fiber Optic Cable	RPG Cables LAPP India CCI Polycab Finolex Universal Cables
12	Enclosures/ Panels	Rittal Pentair Eldon CS
13	Gas detectors and monitoring	Honeywell, Industrial Scientific, MSA (Mine Safety Appliance), RAE system

AUTOMATION:

Sr. No.	Description	Vendor/Supplier/Make
1	Work station Servers	Dell HP IBM (Lenovo)
2	Programming Unit (Laptop)	Toshiba Dell HP IBM (Lenovo)
3	Printers	HP Canon Epson
4	Programmable Logic Controllers	Allen Bradley ABB Siemens GE Schneider Electric
5	SCADA Programming Software	Intellution iFix Wonderware Visio Citect WIN CC V 6.2 RS View

LIST OF APPROVED MANUFACTURERS/MAKES - CIVIL

Sr. No.	Description	Make
1.	Reinforcement	TATA SAIL RINL JSW TISCO
2.	RMC	ACC Lafarge Godrej
3.	Curing Compound	BASF
4.	Admixure	MASTERKURE 107i of BASF
5.	Expansion / Movement Joint	PCI Escutan TF by BASF
6.	Cement Grouting	FOSROC BASF ROFF SIKA
7.	Epoxy Grout	FOSROC BASF ROFF SIKA
8.	Epoxy Coating for UG Structures	BASF
9.	Aluminium Windows	Hindalco Industries Ltd Jindal Aluminium Ltd
10.	Glazing	Saint Gobain Asalin Glass Co. Modi, Mumbai
11.	Pest Control	Pest Control of India
12.	Steel Plates, stiffeners	JINDAL SAIL ESSAR ISPAT TISCO.

CONTRACT FORMS

PART 1 - GENERAL

1.01 Reference:

A. Section 01000 applies to and governs the work of this Section.

1.02 General:

A. Use the forms listed below as applicable.

B. Prepare similar forms as required for items not covered below and submit to the Engineer for approval.

C. Each Form shall have the MCGM name, Project No., Project Name, Contractor Name, Name of equipment/material, Specification number, Tag number, location, name of persons who perform test and /or inspection, dates etc information/ detailed.

Form No.	Title
01300-A	Submittal Transmittal Form
01700-A	Operation and Maintenance Transmittal Form
11000-A	Equipment Test Report Form
11000-B	Manufacturer's Installation Certification Form
11000-C	Manufacturer's Instruction Certification Form
11005-A	Motor Data Form
13000-A	Loop Wiring and Insulation Resistance Test Data Form
13000-B	Control Circuit Piping Leak Test Form
13000-C	Controller Calibration Test Data Form
13000-D	Panel Indicator Calibration Test Data Form
13000-E	Recorder Calibration Test Data Form
13000-F	Signal Trip Calibration Test Data Form
13000-G	Field Switch Calibration Test Data Form
13000-H	Transmitter Calibration Test Data Form
13000-I	Miscellaneous Instrument Calibration Test Data Form
13000-J	Individual Loop Test Data Form
13000-K	Loop Commissioning Test Data Form
16000-A	Wire and Cable Resistance Test Data Form
16000-B	Installed Motor Test Data Form
16000-C	Dry Transformer Test Data Form
16000-D	Motor Control Centre Test Form
16000-E	Medium Voltage Motor Starter Test Form
16000-F	Medium Voltage Switchgear Test Form
16000-G	Protective Relay Test Form
16000-H	Low Voltage Switchgear Test Form
16000-I	Medium Voltage Load Interrupter Switch Test Form
16000-J	Liquid-Filled Transformer Test Form
16000-K	Automatic Transfer Switch Test Form
16000-L	Neutral Grounding Resistor Test

01300 - A SUBMITTAL TRANSMITTAL FORM:

Submittal Description: _____ Submittal No:[1] _____

Spec Section: _____

		Issued	Received
OWNER: MCGM	Contractor/Engineer		
PROJECT:	Engineer/Contractor		
CONTRACTOR:			

We are sending you
- ☐ Attached
- ☐ Design Documents / Drawings
- ☐ Shop Drawings
- ☐ Submittals for review and comment
- ☐ Submittals for information only
- ☐ Under separate cover via _____

Remarks: _____

Item	Copies	Date	Section No.	Description	Review action[a]	Reviewer initials	Review comments attached

[a]**Note: APPROVED AS SUBMITTED = No exceptions taken;**
APPROVED SUBJECT TO COMMENTS NOTED = Make corrections noted;
RESUBMIT AS NOTED = Amend and resubmit;
RETURNED WITHOUT REVIEW = Rejected
(Attach additional sheets if necessary)

Contractor

Certify either **A, B** or **C**:

☐ **A** We have verified that the design or material or equipment contained in this submittal meets all the requirements, including coordination with all related work, specified (no exceptions).

☐ **B** We have verified that the design, material or equipment contained in this submittal meets all the requirements specified except for the attached deviations.

No.	Deviation

☐ **C** For shop drawings submission, we have indicated compliance with Contract requirements and deviations from Contract requirements through the inclusion of marked-up specification(s).

Certified by: _____
Contractor's Signature

[1]See Section 01007, Transmittal Procedure for Submittals.

01700 - A OPERATION AND MAINTENANCE TRANSMITTAL FORM:

Date: _____ Submittal No: _____

To: _____ Contract No: _____

_____ Spec. Section: _____

_____ Submittal Description: _____

_____ From: _____

Attention: _____

Checklist	Contractor			
	Satisfactory	N/A		
1. Table of contents				
2. Equipment record forms				
3. Manufacturer information				
4. Vendor information				
5. Safety precautions				
6. Operator prestart				
7. Start-up, shutdown, and post-shutdown procedures				
8. Normal operations				
9. Emergency operations				
10. Operator service requirements				
11. Environmental conditions				
12. Lubrication data				
13. Preventive maintenance plan and schedule				
14. Troubleshooting guides and diagnostic techniques				
15. Wiring diagrams and control diagrams				
16. Maintenance and repair procedures				
17. Removal and replacement instructions				
18. Spare parts and supply list				
19. Corrective maintenance man-hours				
20. Parts identification				
21. Warranty information				
22. Personnel training requirements				
23. Testing equipment and special tool information				

Remarks: _____ Contractor's Signature

11000 - A EQUIPMENT TEST REPORT FORM: Page 1 of 4

NOTE: This example equipment test report is provided for the benefit of the Contractor and is not specific to any piece of equipment to be installed as a part of this project. The example is furnished as a means of illustrating the level of detail required for the preparation of equipment test report forms for this project.

SAMPLE

Client Name - Municipal Corporation of Greater Mumbai
Project Name - Upgradation of Ghatkopar Influent Pumping Station & Carrying Capacity of Rising Main to Design PFF Capacity of 699 MLD
Name of Contractor: **xxxxxx**

EQUIPMENT TEST REPORT

Equipment Name: XXXX
Equipment Number: XXXXXXX
Specification Ref: XXXXXX
Location: XXXXXXX

	Contractor		Engineer	
	Verified	Date	Verified	Date
PRE-OPERATIONAL CHECKLIST				
Mechanical				
Lubrication	_____	_____	_____	
Alignment	_____	_____	_____	
Anchor bolts	_____	_____	_____	
Seal water system operational	_____	_____	_____	
Equipment rotates freely	_____	_____	_____	
Safety guards	_____	_____	_____	
Valves operational	_____	_____	_____	
Hopper purge systems operational	_____	_____	_____	
Sedimentation tank/hopper clean	_____	_____	_____	
O&M manual information complete	_____	_____	_____	
Manufacturer's installation certificate Complete.	_____	_____	_____	

11000 – A EQUIPMENT TEST REPORT FORM (continued):

	Contractor		Engineer	
	Verified	Date	Verified	Date
Electrical (circuit ring-out and high-pot tests)				
Circuits:				
Power to MCC				
Control to HOA				
Indicators at MCC:				
Red (running)				
Green (power)				
Amber (auto)				
Indicators at local control panel				
Wiring labels complete				
Nameplates:				
MCC				
Control station				
Control panel				
Equipment bumped for rotation				
Piping Systems				
Cleaned and flushed:				
Suction				
Discharge				
Pressure tests				
Temporary screens in place				
Instrumentation and Controls				
Flow meter calibration				
Calibration Report No._____				
Flow recorder calibrated against transmitter				
VFD speed indicator calibrated against independent reference				
Discharge overpressure shutdown switch calibration				
Simulate discharge overpressure				

Shutdown				

11000 - A EQUIPMENT TEST REPORT FORM (continued): Page 3 of 4

	Contractor		Engineer	
	Verified	Date	Verified	Date

FUNCTIONAL TESTS

Mechanical

Motor operation temperature satisfactory	_____	_____	_____	_____
Pump operating temperature Satisfactory	_____	_____	_____	_____
Unusual noise, etc?	_____	_____	_____	_____
Pump operation:	_____	_____	_____	_____
Measurement:				
Flow	_____	_____	_____	_____
Pressure _____	Test gage number _____			
Alignment hot	_____	_____	_____	_____
Dowelled in	_____	_____	_____	_____

Remarks: _____

Electrical

Local switch function:				
Runs in *HAND*	_____	_____	_____	_____
No control power in *OFF*	_____	_____	_____	_____
Timer control in *AUTO*	_____	_____	_____	_____
Overpressure protection switch PS2502C functional in both *HAND* and *AUTO*	_____	_____	_____	_____
Overpressure protection switch PS2502C set at 75 psig	_____	_____	_____	_____
PLC 2500 set at 24-hour cycle, 25 min *ON*	_____	_____	_____	_____

OPERATIONAL TEST

48-hour continuous test. Pump cycles as specified, indicators functional, controls functional, pump maintains capacity, overpressure protection remains functional, hour meter functional	_____	_____	_____	_____

11000 - A EQUIPMENT TEST REPORT FORM (continued): Page 4 of 4

RECOMMENDED FOR BENEFICIAL OCCUPANCY

Contractor _____ Date _____

ACCEPTED FOR BENEFICIAL OCCUPANCY

MCGM's Representative _____ Date _____

11000 – B MANUFACTURER'S INSTALLATION CERTIFICATION FORM:

Contract No: _____ Specification section: _____

Equipment name: _____

Contractor: _____

Manufacturer of equipment item: _____

The undersigned manufacturer of the equipment item described above hereby certifies that he has checked the installation of the equipment and that the equipment, as specified in the project manual, has been provided in accordance with the manufacturer's recommendations, and that the trial operation of the equipment item has been satisfactory.

Comments: _____

_____

_____

_____

_____

_____ _____

Date Manufacturer

_____

Signature of Authorized Representative

_____ _____

Date Contractor

_____

Signature of Authorized Representative

11000 – C MANUFACTURER'S INSTRUCTION CERTIFICATION FORM:

Contract No: _____ Specification section: _____

Equipment name: _____

Contractor: _____

Manufacturer of equipment item: _____

The undersigned manufacturer certifies that a service engineer has instructed the influent pumping station operating personnel in the proper maintenance and operation of the equipment designated herein.

Operations Check List (check appropriate spaces)

Start-up procedure reviewed	_____
Shutdown procedure reviewed	_____
Normal operation procedure reviewed	_____
Others: _____	_____
_____	_____
_____	_____

Maintenance Check List (check appropriate spaces)

Described normal oil changes (frequency)	_____
Described special tools required	_____
Described normal items to be reviewed for wear	_____
Described preventive maintenance instructions	_____
Described greasing frequency	_____
Others: _____	_____
_____	_____
_____	_____

_____ _____
Date Manufacturer

_____
Signature of Authorized Representative

_____ _____
Date Signature of MCGM's Representative

_____ _____
Date Signature of Contractor's Representative

11005 - A MOTOR DATA FORM:

Equipment Name_____ Equipment No.(s) _____

Site Location _____

Nameplate Markings

Mfr _____ Mfr Model _____ Frame _____ KW____

Volts _____ Phase _____ RPM _____ Service factor _____

FLA _____ LRA ____ Freq _____ Amb temp rating _____degrees C

Time rating _____ Design letter _____
(NEMA MG1-10.35) (NEMA MG-1.16)

KVA code letter _____ Insulation class _____

The following information is required for motors:

A. Approved by UL for installation in Class _____, Div _____

B. UL frame temperature code _____; Group _____ Atmosphere
(NEC Tables 500-2 and 500-2(b))

The following information is required for all motors 1/2 horsepower and larger:

A. Guaranteed minimum efficiency _____
(Part 2 of Section 11005)

B. Nameplate or nominal efficiency _____

Data Not Necessarily Marked on Nameplate

Type of enclosure _____ Enclosure material_____

Temp rise _____degrees C (NEMA MG1-12.41,42)

Space heater included?_____Yes _____ No; if Yes, _____watts _____volts

Type of motor winding over-temperature protection, if specified: _____

Use the space below to provide additional information on other motor modifications, if specified:

_____

_____

_____

13000 - A LOOP WIRING AND INSULATION RESISTANCE TEST DATA FORM:

Loop No.:_____

List all wiring associated with a loop in table below. Make applicable measurements as indicated after disconnecting wiring.

			Continuity Resistance [a]		Insulation Resistance [b]			
Wire No.	Panel Tie	Field TB	Cond./ Cond.	Cond./ Shield	Shield/ Gnd.	Shield/ Cond.	Cond./ Gnd.	Shield/ Shield
A			--	(A/SH)				
B			(A/B)	--				
C			(A/C)	--				
D			(A/D)	--				
etc.								

a. Continuity Test. Connect ohmmeter leads between wires A and B and jumper opposite ends together. Record resistance in table. Repeat procedure between A and C, A and D, etc. Any deviation of ±2 ohms between any reading and the average of a particular run indicates a poor conductor, and corrective action shall be taken before continuing with the loop test.

b. Insulation Test. Connect one end of a 500 volt megger to the panel ground bus and the other sequentially to each completely disconnected wire and shield. Test the insulation resistance and record each reading.

CERTIFIED _____ Date_____
Contractor's Representative

WITNESSED _____ Date_____
MCGM's Representative

13000 - B CONTROL CIRCUIT PIPING LEAK TEST DATA FORM:

Loop No.:_____

List tubing associated with loop in table below. Make applicable measurements after isolating any air consuming pilots from circuit.

Tube No.	Tubing Equivalent Length of 6mm Copper[a]	Test Period (seconds)	Permitted Pressure Drop (kPa)[b]	Measured Pressure Drop (kPa)
A				
B				
C				
D				
Etc.				

a. Convert actual tubing and air motor volume to equivalent 6 mm copper tubing.

b. Pressure drop shall not exceed 20 kPa per hundred metres 6 mm tubing per 5 seconds.

CERTIFIED _____ Date_____
Contractor's Representative

WITNESSED _____ Date_____
MCGM's Representative

13000 - C CONTROLLER CALIBRATION TEST DATA FORM: _____

Tag No. and Description: _____

Make and Model No.:_____ Serial No.:_____

Input:_____ Process Variable (PV) Scale: _____

Output:_____ Output Scale: _____

PV Scale Calibration

% of Range	Expected Input	Actual Reading	% Deviation
0			
50			
100			

% Deviation Allowed: _____

Connect output to PV for following tests:

Set Point (SP) Indicator Accuracy			Output Meter Accuracy			Controller Accuracy		
SP	PV Reading	Expected % Dev.	Actual Reading	Expected Reading	Actual % Dev.	Output	Output	% Dev.
(0%)								
(50%)								
(100%)								

%Dev. Allowed: _____ % Dev. Allowed:_____ % Dev. Allowed:_____

CERTIFIED _____ Date_____
Contractor's Representative

WITNESSED _____ Date_____
MCGM's Representative

13000 - D PANEL INDICATOR CALIBRATION TEST DATA FORM:

Tag No. and Description: _____

Make and Model No.: _____ Serial No.: _____

Input: _____

Scale: _____ Range: _____

PV Scale Calibration

% of Range	Input	Expected Reading	Actual Reading	% Deviation
0				
50				
100				

% Deviation Allowed: _____

CERTIFIED _____ Date _____
Contractor's Representative

WITNESSED _____ Date _____
MCGM's Representative

13000 - E RECORDER CALIBRATION TEST DATA FORM: _____

Tag No. and Description: _____

Make and Model No.:_____ Serial No.: _____

Input:_____ Chart: _____

Scale:_____ Range:_____

% of Range	Input	Expected Scale Reading	Actual Scale Reading	% Deviation
0				
50				
100				

% Deviation Allowed:_____

CERTIFIED _____ Date_____
Contractor's Representative

WITNESSED _____ Date_____
MCGM's Representative

13000 - F SIGNAL TRIP CALIBRATION TEST DATA FORM:

Tag No. and Description: _____

Make and Model No.:_____ Serial No.: _____

Input:_____

Scale:_____ Range:_____

Set Point(s):_____

After setting set point(s), run signal input through entire range and calculate deadband.

Set Point	Incr. Input Trip Point	Decr. Input Trip Point	Calc. Deadband	Required Deadband

CERTIFIED _____ Date_____
Contractor's Representative

WITNESSED _____ Date_____
MCGM's Representative

13000 - G FIELD SWITCH CALIBRATION TEST DATA FORM:

Tag No. and Description: _____

Make and Model No.:_____ Serial No: _____

Input:_____

Range:_____

Set Point(s):_____

Simulate process variable (flow, pressure, temperature, etc.) and set desired set point(s). Run through entire range of switch and calculate deadband.

Set Point	Incr. Input Trip Point	Decr. Input Trip Point	Calc. Deadband	Required Deadband

CERTIFIED _____ Date_____
Contractor's Representative

WITNESSED _____ Date_____
MCGM's Representative

13000 - H TRANSMITTER CALIBRATION TEST DATA FORM: _____

Tag No. and Description: _____

Make and Model No.:_____ Serial No.: _____

Input:_____

Output:_____

Range:_____ Scale: _____

Simulate process variable (flow, pressure, temperature, etc.) and measure output with appropriate meter.

% of Range	Input	Expected Output	Actual Output	% Deviation
0				
50				
100				

% Deviation Allowed:_____

CERTIFIED _____ Date_____
Contractor's Representative

WITNESSED _____ Date_____
MCGM's Representative

13000 - I MISCELLANEOUS INSTRUMENT CALIBRATION TEST DATA FORM:

(For instruments not covered by any of the preceding test forms, the Contractor shall create a form containing all necessary information and calibration procedures.)

CERTIFIED _____ Date _____
Contractor's Representative

WITNESSED _____ Date _____
MCGM's Representative

13000 - J INDIVIDUAL LOOP TEST DATA FORM:

Loop No.:_____

Description: (Give complete description of loop's function using tag numbers where appropriate.)

P&ID No.: (Attach copy of P&ID.)

a. Wiring tested:
(Attach test form 13000-A)

b. Instrumentation tubing/piping tested:
(Attach test form 13000-B)

c. Instruments calibrated:
(Attach test forms 13000-C through I)

d. List step-by-step procedures for testing loop parameters. Test loop with instruments, including transmitters and control valves, connected and functioning. If it is not possible to produce a real process variable, then a simulated signal may be used with the Engineer's approval.

CERTIFIED _____ Date_____
Contractor's Representative

WITNESSED _____ Date_____
MCGM's Representative

13000 - K LOOP COMMISSIONING TEST DATA FORM:

Loop No.:_____

a. Loop tested:
(Attach test form 13000-J)

b. Controlled or connected equipment tests confirmed:

c. Give complete description of loop's interface with process.

d. With associated equipment and process in operation, provide annotated chart trace of loop response to changes in set points for verification of performance. This chart should demonstrate 1/4-amplitude damping as output adjusts to set point change. Show set points, starting and finishing times on chart, as well as any other pertinent data.

Connect 2-pen recorder to process variable (PV) and to controller output. Use 1 inch/second chart speed.

Pen 1 - PV - Connections:

Pen 2 - Output - Connections:

CERTIFIED _____ Date_____
Contractor's Representative

WITNESSED _____ Date_____
MCGM's Representative

16000 - A WIRE AND CABLE RESISTANCE TEST DATA FORM:

Wire or Cable No.:_____ Temperature, ^{o}C _____

Location of Test	Insulation resistance, megohms
1.	
2.	
3.	
4.	
5.	
6.	
7.	

CERTIFIED _____ Date_____
Contractor's Representative

WITNESSED _____ Date_____
MCGM's Representative

16000 - B INSTALLED MOTOR TEST FORM:

Motor Equipment Number _____ Date of test _____

Equipment Driven _____

MCC Location _____

Ambient temp _____ ^{o}C

Resistance:

Insulation resistance phase-to-ground megohms:

Phase A _____, Phase B _____, Phase C _____

Current at Full Load:

Phase _____ Current, amps _____

Phase _____ Current, amps _____

Phase _____ Current, amps _____

Thermal Overload Device: Manufacturer/catalog # _____ Amperes _____

Circuit breaker (MCP) setting: _____

Motor Nameplate Markings:

Mfr _____ Mfr type _____ Frame _____ KW_____

Volts _____ Phase _____ RPM _____ **Service factor _____

Amps _____ Freq _____ Ambient temp rating _____ ^{o}C

Time rating _____ **Design letter _____
(NEMA 1-10.35) (NEMA MG-1.16)

Code letter _____ Insulation class _____

**Required for 3-phase squirrel cage induction motors only.

CERTIFIED _____ Date_____
Contractor's Representative

WITNESSED _____ Date_____
MCGM's Representative

16000 - C DRY TRANSFORMER TEST DATA FORM:

Equipment No. _____ Temperature _____
Location _____
Winding: Primary _____ Secondary _____

A. INSULATION-RESISTANCE TEST:

The test shall be made with a megohmmeter at the test voltage for a period of 1 minute.

Voltage rating	Test voltage	Test results (megohms) Phase	Phase
0-600	1000	A-GRD ____	A-B ____
601-5000	2500	B-GRD ____	B-C ____
5000+	5000	C-GRD ____	C-A ____

Resistance readings less than the manufacturer's recommended value or less than 12 megohms shall be brought to the attention of the Engineer.

B. DIELECTRIC-ABSORPTION TEST:

The test shall be made with a megohmmeter at the test voltage for a period of 10 minutes.

1. TEST RESULTS: (megohms)

Phase	Phase
A-GRD ____	A-B _____
B-GRD ____	B-C _____
C-GRD ____	C-A _____

2. POLARIZATION INDEX:

$$\frac{10\ minute\ reading}{1\ minute\ reading} = polarization\ index$$

(from paragraph "A" above)

Phase	Phase
A-GRD ____	A-B ____
B-GRD ____	B-C ____
C-GRD ____	C-A ____

Polarization index values less than 2 shall be brought to the attention of the Engineer.

CERTIFIED _____ Date _____
Contractor's Representative

WITNESSED _____ Date _____
MCGM's Representative

16000 - D MOTOR CONTROL CENTER TEST FORM:

Equipment No. _____ Ambient room temperature _____

Location _____

A. MECHANICAL CHECK:

All bolted connections either bus to bus or cable to bus shall be torqued to the manufacturer's recommendations.

B. ELECTRICAL TESTS:

1. Measure insulation resistance of each bus section phase to phase and phase to ground for 1 minute using a megohmmeter at 1000 volts.

Test results (megohms)

Phase		Phase
A-GRD_	A-B	_____
B-GRD_	B-C	_____
C-GRD_	C-A	_____

2. Set the circuit breaker in the starter unit to comply with the requirements of NEC, Article 430-52 and Table 430-152.

3. Motor overload heater elements shall be sized and installed based on the actual nameplate full load amperes of the motor connected to the starter.

CERTIFIED _____ Date_____
Contractor's Representative

WITNESSED _____ Date_____
MCGM's Representative

16000 - E MEDIUM VOLTAGE MOTOR STARTER TEST FORM:

Equipment No. _____

Location _____

Room Temperature _____

The protective devices shall be set in accordance with the specification before the tests are performed.

1. Measure contact resistance (micro-ohms)
   Phase: A_____ B_____ C _____

   Contacts shall be replaced if resistance exceeds 50 micro-ohms.

2. Perform an insulation resistance test (1000 volts DC for 1 minute).

Phase	A	B	C	
Pole to ground	___	___	___	megohms
Across open pole	___	___	___	megohms
Pole to pole	AB_____	BC_____	CA_____	megohms

3. Perform minimum pickup voltage tests on trip and close coils.

4. Test motor RTDs by using a hot oil bath. Record the temperature at which the sensor trips for each RTD.

5. The Contactor shall be tripped by operation of each protective device.

16000 - F MEDIUM VOLTAGE SWITCHGEAR TEST FORM: _____

Equipment No. _____

Location _____

Room Temperature _____

The protective devices shall be set in accordance with the specification before the tests are performed.

1. Measure contact resistance (micro-ohms)
   Phase: A____ B____ C _____

   Contacts shall be replaced if resistance exceeds 50 micro-ohms.

2. Perform an insulation resistance test (1000 volts DC for 1 minute).

Phase	A	B	C	
Pole to ground	___	___	___	megohms
Across open pole	___	___	___	megohms
Pole to pole	AB___	BC___	CA___	megohms

3. Perform minimum pickup voltage tests on trip and close coils.

4. Verify the instrument transformer ratios. Check the transformer's polarity electrically.

5. The Contactor shall be tripped by operation of each protective device.

16000 - G PROTECTIVE RELAY TEST FORM:

Location _____

Switchgear Breaker No. _____

Protective Relay Description _____

The protective relays shall be tested in the following manner:

1. Each protective relay circuit shall have its insulation resistance tested to ground.
2. Perform the following tests on the specified relay setting:
    a. Pickup parameters on each operating element.
    b Timing test shall be performed at three points on the time dial curve.
    c. Pickup target and seal-in units.

The results shall be recorded and signed. A copy shall be given to the Engineer.

16000 - H LOW VOLTAGE SWITCHGEAR TEST FORM:

Equipment No. _____

Location _____

Room Temperature _____

The protective devices shall be set in accordance with the specification before the tests are performed.

1. Measure contact resistance (micro-ohms)

   Phase: A_____ B_____ C____

   Contacts shall be replaced if resistance exceeds 50 micro-ohms.

2. Perform an insulation resistance test (1000 volts DC for 1 minute).

Phase	A	B	C	
Pole to ground	____	____	____	megohms
Across open pole	____	____	____	megohms
Pole to pole	AB	BC	CA	megohms

3. Minimum pickup current shall be determined by primary current injection.

4. Long time delay shall be determined by primary injection at three hundred percent (300%) pickup current.

5. Short time pickup and time delay shall be determined by primary injection of current.

6. Instantaneous pickup current shall be determined by primary injection.

7. Trip unit reset characteristics shall be verified.

8. Auxiliary protective devices, such as ground fault or under voltage relays, shall be activated to ensure operation of shunt trip devices.

16000 - I MEDIUM VOLTAGE LOAD INTERRUPTER SWITCH TEST FORM:

Equipment Number _____

Location _____

Date _____

1. Measure switch blade resistance (micro-ohms).

   Phase: A_____ B_____ C_____

Contacts shall be replaced if resistance exceeds 50 micro-ohms.

2. Perform an insulation resistance test (1000 volts DC for 1 minute).

Phase	A	B	C	
Pole to ground	___	___	___	megohms
Across open pole	___	___	___	megohms
Pole to pole	AB ___	BC ___	CA ___	megohms

The results shall be recorded and signed. A copy shall be given to the Engineer.

CERTIFIED _____ Date_____
Contractor's Representative

WITNESSED _____ Date_____
MCGM's Representative

16000 - J LIQUID-FILLED TRANSFORMER TEST FORM:

Equipment Number _____

Location _____

Date/Weather Conditions _____

A. Perform the "Insulation-Resistance Test" and "Dielectric Absorption Test" using Form 16000-C, Dry Transformer Test Data Form.

B. Perform an applied voltage (low frequency dielectric) test in accordance with ANSI C57.12.90, paragraph 10.5, Applied Voltage Test. Applied voltage levels shall be 75 percent of recommended factory test levels or recommended test levels of ANSI C57.12.00, Table 5.

C. Insulating oil shall be sampled and shall be laboratory tested for the following:

1. Dielectric strength.
2. Acid neutralization.
3. Interfacial tension.
4. Color.
5. Power factor.

D. Perform a turns ratio test between the windings for all tap positions.

E. The temperature and pressure switches shall be tested using a hot oil bath and air pump.

The results shall be recorded and signed by the Contractor and Engineer. A copy shall be given to the Engineer. Any readings which are abnormal to ANSI industry standards shall be reported to the Engineer.

16000 - K AUTOMATIC TRANSFER SWITCH TEST FORM:

Equipment Number _____

Location _____

Date _____

1. Perform an insulation resistance test (1000 volts DC for 1 minute):

	Phase A	Phase B	Phase C	
Pole to ground	___	___	___	megohms
Pole to pole	AB___	BC___	CA___	megohms

2. Perform the following operations and initial:

   a. Manual transfer _____

   b. Loss of normal power; ___sec delay

   c. Return to normal power; ___sec delay

The results shall be recorded and signed. A copy shall be given to the Engineer.

CERTIFIED _____ Date_____
Contractor's Representative

WITNESSED _____ Date_____
MCGM's Representative

16000 - L NEUTRAL GROUNDING RESISTOR TEST:

Equipment No. _____

Location _____

The pickup and time delay setting on the ground fault relay shall be set in accordance with Section 16431.

1. The transformer neutral insulation resistance shall be measured with and without the grounding resistor connected to insure no parallel ground paths exist.

2. The protective relay pickup current shall be determined by injecting test current into the current sensor. The pickup current should be within 10 percent of the dial setting. Record the dial setting and actual pickup tie.

3. The relay timing shall be tested by injecting 150 and 300 percent of pickup current into the current sensor. The relay timing shall be in accordance with the manufacturer's published time-current characteristic curves. Record the relay timing at 150 and 300 percent of pickup current.

4. The circuit interrupting device shall be operated by operating the relay.

The results shall be recorded and signed by the Contractor and Engineer. A copy shall be given to the Engineer.

END OF SECTION 01017